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An Optimization Algorithm for Congestion Control

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Abstract: The Mobile Ad Hoc Networks (MANETs) is a self configured network of mobile devices connected by wireless links. The main problem with Mobile Ad Hoc Networks (MANETs) is how to find out the best shortest path (optimize route). There are several studies and research are done to find out the optimize route but they may fail to find optimize path. Beside that Ant Colony Optimization Routing Algorithm (ACRA) give better and effective results which are close to optimize path in our study we design LOCANT (Location Based Ant Colony Optimization Routing). It combines the methodology of ACRA with Position Based Routing Algorithms which contains information about location of nodes. LOCANT is able to find optimize routes when a given network contains nodes of different transmission ranges.

Keywords: MANETs (Mobile Ad Hoc Networks), LOCANT (Location based ANT colony optimization routing algorithm), ACRA (Ant Colony Optimization Routing Algorithm.)

1. INTRODUCTION

Till present time, so many studies and research techniques are proposed for resolving and finding the routing problem in MANETs. The problem of finding shortest and best path in between the communication end point is the biggest challenge in Mobile Ad Hoc Networks (MANETs). MANET is an infrastructure less network which doesn't rely on any infrastructure to work. It is made-up of multiple "nodes" here each node can directly communicate with other node furthermore, the range of transmission of each node is limited and for reaching up to destination, a message have to pass through its intermediary neighbour nodes. Therefore one of the biggest and challenging problems is find the shortest path between the communication end points. In our study we refer and follow different routing algorithms such as ANTNET[5], ANTHOC [4], and GPSR[12] .In our study we PRESENT a new reactive routing algorithm which is based on ant colony optimization and with position based routing algorithm which uses information about the location of nodes. Since our algorithm is a location based ant colony routing algorithm, we call it LOCANT (LOCation based ANT colony optimization routing algorithm). Our study shows that LOCANT reduces the route establishment time while keeping the number of generated ants much smaller in comparison to other ant colony based routing algorithms.

The rest of the paper is listed below as in the (2nd) section we specify our Related Routing Algorithms and Model. Then in section (3rd) we describe the LOCANT in more details and section (4th) simulation results of LOCANT and a comparison with other routing algorithm and conclusion is given in the section (5th).

Related Routing Algorithms and Model

In this section we give a brief description related algorithm which we refer are as given in 2nd (i), 2nd (ii) and 2nd (iii).

Ant Colony Based Routing Algorithm

The overall idea of ant colony based routing [5] [4] [9] [11] [15] is comes from the natural world where ants wander here and there for the searching of food when an ant returns to their colony they spread pheromone on the way. The other ants follow the same pheromone laid path and reinforce it. After sometime the pheromone level increase by the ants on the minimum distance path because the ant obviously using the shorter path and the distant path will be for granted due to low level of pheromone the shortest path will be identified and most probably ant will only follow that path.

Fig.1. Ant Pheromone trail.

2. ANTHOCNET & ANTNET

ANTHOCNET [4] is combination of reactive route establishment & proactive route maintenance which makes it a hybrid multipath routing algorithm. In ANTHOCNET the paths are set according to the pheromone tables which indicate their respective quality. After the route setup, data packets are routed randomly over the different paths following these pheromone tables.

ANTNET [5] is a table-driven (proactive) Ant Colony Optimization Routing Algorithm (ACRA) for packet switched networks. In this routing algorithm, a forward ant is launched from the source node at regular intervals of time. A forward ant at each intermediate node selects the next hop using the information stored in the routing table of the node. The next node is select with a probability proportional to the goodness of that node which is measured by the amount of pheromone deposited on the link to the node.

Position Based Routing Algorithm

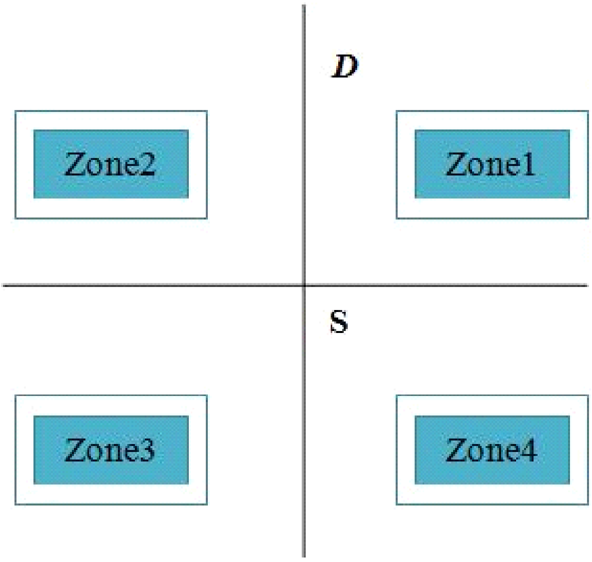
In Position Based Routing Algorithm it is assume that a node is aware of its position, the position of its neighbors, and the position of the destination. The position of nodes in a network can be estimate by the instruments like GPS receivers which motivated researchers to propose position based routing algorithm. Such as GPSR [12] and DIR

LOCANT: location based ant colony routing algorithm

LOCANT is a location based ant colony optimization routing algorithm which use location information to improve efficiency. LOCANT is reactive in nature that's why the route is searched for only when there is a collection of data packets that are to be sent from a source node to a destination node. LOCANT is able to find optimum routes when a given network contains nodes of different transmission ranges. The next phase in our algorithm is concept of zones.

Zones:

Assume a graph G having destination node D .For each node S (S is not necessarily the source node) we partition its neighbours into 4 zones called zone1,



zone2, zone3 & zone 4 as in Figure 2(a).

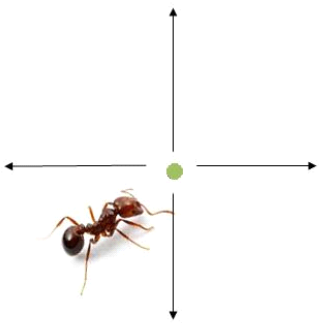
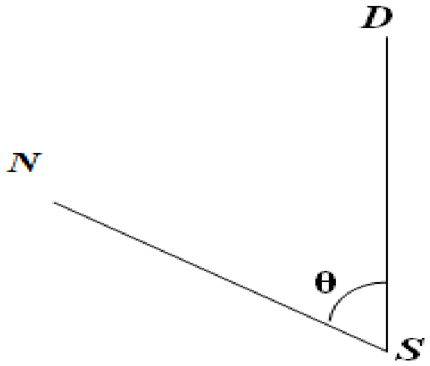


Figure.2: (a) Different zones of neighbours for destination node D

Consider a line segment from S to D. For a neighbour N of S, angle θN is defined as the angle between the line segments SN and SD. Node N belongs to



Zone1 if $\theta N \leq \pi/4$
Zone2 if $\pi/4 < \theta N \leq \pi/2$
Zone3 if $\pi/2 < \theta N \leq 3\pi/4$
Zone4 if $3\pi/4 < \theta N \leq \pi$

Figure2: (b) θ is the angle between SN and SD

Reinforcement of Pheromone:

For start route establishment process, the amount of pheromone deposited in the edges of the graph must be initialized. For each node like A in the network, a pheromone trail is assigned to each of its outgoing links. Suppose B is one of the neighbours of A. To initialize the value of deposited pheromone on vector AB the assigned values decrease with the zone number, having four values ν1, ν2 ,ν3 and ν4 such that $\nu 1 \geq \nu 2 \geq \nu 3 \geq \nu 4$, an amount of pheromone equal to νi will be assigned to vector AB if B belongs to zone i. Possibly in most of the cases shortest paths pass through the neighbours whose directions are closer to the direction of the destination. As a result, this initialization causes a faster convergence to a shortest path most of the time. Our study shows that the value of ν1, ν2, ν3 and ν4 has a significant effect on the performance of LOCANT. LOCANT assumes that each node maintains a table of values of the pheromone trails assigned to its outgoing links for different destinations. Whenever a node receives a packet for a specific destination, it will check its table to see if there is at least one pheromone trail for that destination. If such pheromone trail exists, it will be used for making a stochastic decision to choose the next hop. If it doesn't exist, the pheromone initialization process begins and assigns pheromone trails to all the outgoing links. The amount of the deposited pheromone on each link depends on the zone of the corresponding neighbour. The pheromone trails for a specific destination will be deleted from the pheromone trail table of a node if the node doesn't receive any packet pointing to that destination for more than a specific time which is defined to be in the order of seconds. The entries in the Reverse Routing table which are related to that destination will also be deleted after that time.

Route Search

To establish a route, S launches n forward ants with unique sequence numbers from each zone at regular time intervals. In our simulation study, we have set n to be 1. Assigning larger values to n increases the overhead of the algorithm without resulting in any significant improvement. Similar to other ACO routing algorithms, at each node a forward ant makes a stochastic decision which is based on the values of pheromone trails to select the next hop. Suppose that a forward ant is currently residing in node R and this node has m neighbours N1, N2, N3,… Nm and Φi is the amount of pheromone assigned to RNi. The forward ant will select Ni as the next node with a probability pi which is calculated using the following equation.

$$p_i = \Phi_i / \sum_{j=1}^{m} \Phi_j$$

In addition to the pheromone trail table discussed before, each node maintains a Reverse Routing table. Whenever a forward ant enters a node from one of its neighbours, an entry in the Reverse Routing table is done that stores the identifier of the neighbour the forward ant is coming from, the sequence number of the ant and the identifier of the destination. Duplicate forward ants will be destroyed. When a forward ant reaches the destination, it is destroyed and a backward ant (Reverse Route Reply) is sent back to the source. This backward ant has the same sequence number as the corresponding forward ant and traverses the same path to the source using the information stored in Reverse Routing tables. Moving from node B to node A, the backward ant increases the amount of pheromone stored in AB using the following relation,

$$\Phi AB = \Phi AB + g(d) * W(AB)$$

Where d is the length of the travelled path from the destination to node B by the backward ant and g (d) is a decreasing function of d. Function W is a weight function and its value is dependent on the zone of B:

W(AB)

$1.5 \leq W\ i \leq 2.0$ If B is in zone1 of A
$1.0 \leq W\ ii \leq 1.5$ If B is in zone2 of A
$0.5 \leq W\ iii \leq 1.0$ If B is in zone3 of A
$0.0 \leq W\ iv \leq 0.5$If B is in zone4 of A

Using the above weight function yields a faster convergence in most cases because the shortest path usually passes through the nodes which are closer in direction to the destination. Simultaneously an evaporation process causes the amount of pheromone deposited in each link to decrease with time. This is realized by multiplying the current pheromone value by a number e < 1 at regular intervals.

$\Phi\ (AB) = e * \Phi(AB)$

Sometimes, especially at the beginning of route establishment process, some ants may take non-optimum routes to reach the destination. Pheromone evaporation reduces the effect of these non-optimum routes. The above stochastic strategy establishes multiple paths between the source and destination. As a result, in contrast to other position based routing algorithms which usually find a single route to the destination LOCANT is a multipath routing algorithm which has an additional advantage of reduced congestion in the1network.

Algorithm I: "LOCANT routing algorithm" [15]
{S is the source node, D is the destination node and
P is the present node}

For each clock time do
if P = S then
if one of the conditions in Section 3-D is true
then
Send one data packet from each of the four
Zones of P
else
Send one forward ant from each of the four
Zones of P
end if
end if
For each message m in P's buffer do
If (m→type = Forward Ant) or
(m→type = Data Packet) then
Next Hop = Select NextHop (n)
Send m to NextHop
if NextHop = D then
m →type = Backward Ant
end if
else if m→type = BackwardAnt then
find NextHop in P's Back Routing table
Send m to NextHop
Increase Pheromone (NextHop,m)
If NextHop = S then
update averages of packet delays for the
corresponding zone
drop m
end if
end if
end for
Evaporate()
end for

Algorithm II: "Select Next Hop" [15]
Input: node N
For i = 1 to the number of N's neighbours do
Ƥi =
Return neighbour i with probability Ƥi
End for

Delivery of data packets

After defining route to the destination it is very important to deliver the data packets at the right time. Delivery of data packets too early may result in the loss of the packet or may follow a longer route which increases the traffic in the network. On the other hand, sending late increases the delay. The appropriate time for sending data packets is determined as follows: For each of the six zones from the sender to the destination D, the sender calculates the average and standard deviation of the delays reported by backward ants using the hop count. So each backward ant carries the length of the path passed from the destination to its current hop. Whenever a backward ant is received by the sender, we update the average and standard deviation of packet delays for the corresponding zone using the delay reported by this ant. To reduce the effect of old backward ants, we define a fixed size window for each zone that contains recently received backward ants from that zone. The average and standard deviation of delays will be calculated only for the backward ants in the window. When a new backward ant is received, we put it in the window of the corresponding zone discarding the oldest ant when the window size has been attained. Therefore, selecting an appropriate window size is important. If the window size is too small, the average delay calculated from the window.

Information would be too far from the real average. If the window size is very big, existence of very old ants would affect the result for a long time. Suppose αi and σi are the average and standard deviation of the delays reported by the backward ants launched from zone i and residing in the window. If σi is less than a threshold say t, we stop sending forward ants from zone i and start sending data packets instead. If σi, σj < t and ei + c < ej we stop sending forward ants or data packets from zone j. In this formula, c is a constant value which determines how different the length of the established routes can be. If σi is small enough, we can assume that almost all the ants launched from zone i are following routes with almost the same length to the destination. Thus, the algorithm has converged to a route or a group of routes with equal lengths and we can start sending data packets from zone i. If the second condition is true, it means that the algorithm will not converge to a route (or a group of routes with almost the same length) passing through zone j whose length is shorter than or equal to the average length reported by the ants launched from zone i plus a constant value c. In this case the algorithm does not use routes passing through zone j anymore and stops sending data packets or ants from this zone. This is done by removing all the pheromone trials assigned to the outgoing links in zone j for destination D from the pheromone trail table of the source node.

Failure recovery

If a link between two nodes say A and B breaks during transmission between a source S and a destination D, If the source node has only one outgoing link that contains a pheromone trail for D, and this link breaks or a message from this link is received that states there is no route to D, a new route establishment process will begin and sending data packets will be suspended until a new route is found.

Performance evaluation

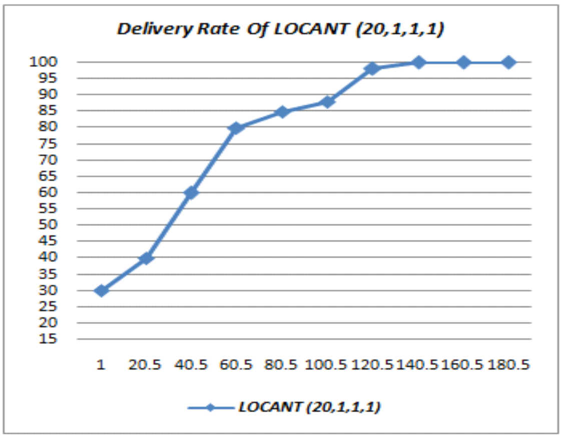
In performance evaluation, we specially focus on the influence of different parameters of LOCANT on its performance and then we carry out a comparison of LOCANT with GPSR, ANTHOCNET and ANTNET by simulating these algorithms on a set of randomly generated networks. In our simulation experiments, we used network connected graphs with 100 nodes randomly and uniformly spread over a square of length 500 units. The transmission range of each node is randomly selected for different directions and its value is between 30 and 50 units. We ran LOCANT algorithm with different values of ν1, ν2 …….. ν4. In the following, Delivery rate and Convergence time are the two performance parameters. Here the average packet delays are computed in terms of hop count. In our simulation study,

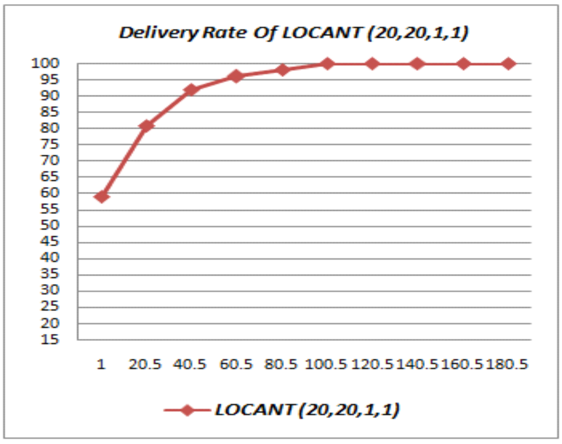
(a) e in equation 4 is set to 0.8.

(b) W1, W2……W4, in equation 3 is set to 1.75, 1.0, 0.75 and 0.5 respectively,

(c) ν1, ν2 ……ν4 is set to 20, 1, 1, and 1

From figures 3 (a) & 3 (b) it is clear that LOCANT (20, 1, 1, 1) has the highest delivery rate and lowest average packet delay. The performance of LOCANT also depends on the value of e, the evaporation rate. From our study we find that LOCANT performs better for e =0.8. W1, W2, W3, W4 in equation 3 do not have much significance in the performance of LOCANT.





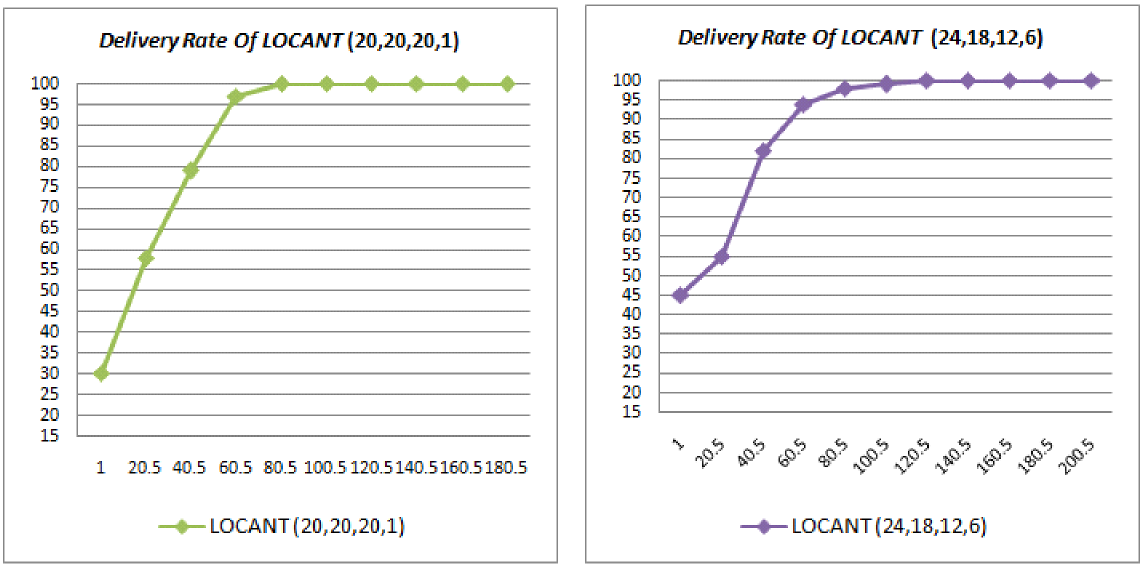
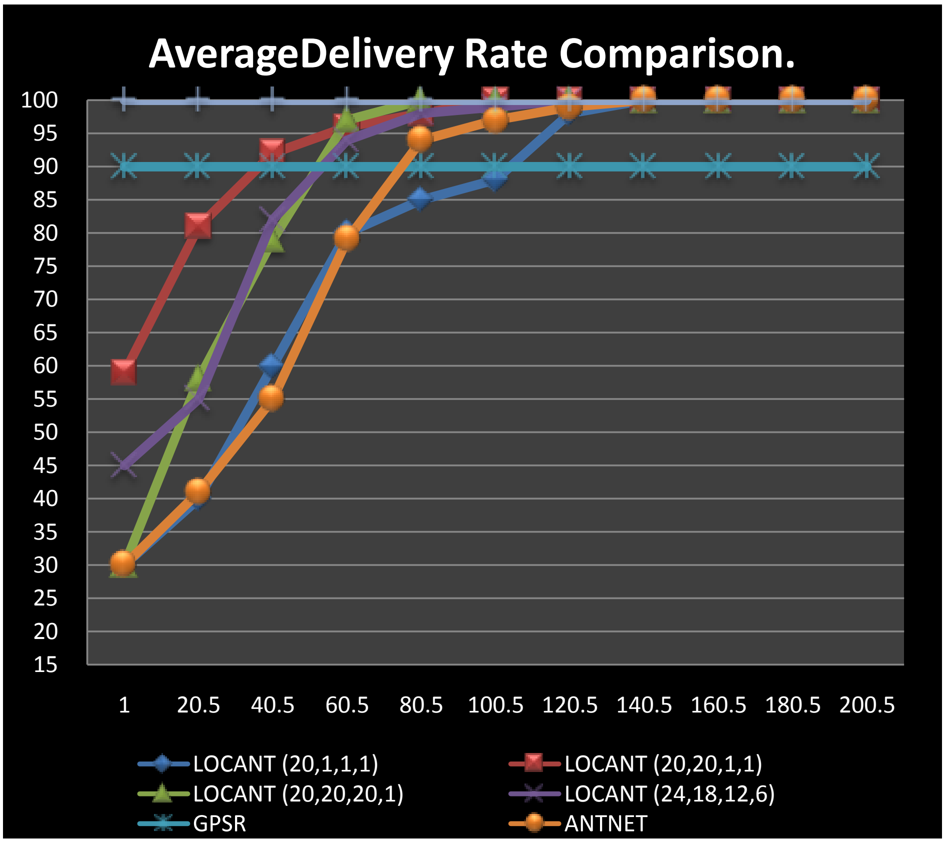


Fig.3: (a) Delivery rates of LOCANT



A comparison of LOCANT to other routing algorithm

Fig 3: (b) Average delivery rate of LOCANT, GPSR, ANTNET & ANTHOCNET

Delivery rate:

In Figure 3 (b) the average delivery rate of LOCANT, GPSR, ANTNET & ANTHOCNET is compared. This figure shows how the average delivery rate varies with time. As the time progresses, the delivery rate increases and eventually becomes almost 100% for all algorithms except GPSR. As the graph shows, ANTHOCNET reaches to 100% delivery rate faster than the others. This is the result of broadcasting ants in this algorithm. GPSR always has a relatively low delivery rate. It is because this algorithm fails in some cases as a result of varying transmission ranges of the nodes. LOCANT (20, 1, 1, 1) has the highest delivery rate among the others. ANTNET and

LOCANT (20, 20, 20, 20) reach to 100% delivery rate slower than the other ant based algorithms.

Convergence time:

In this section the average packet delay of LOCANT is compared with that of GPSR, ANTNET & ANTHOCNET. The results of this comparison are presented in Figure4 (b) how the average packet delays for the different algorithms vary with time. In the beginning, the average packet delay of ANTHOCNET is smaller than the others. GPSR has a relatively small average delay at the beginning but it is still longer than that of ANTHOCNET. It is because GPSR doesn't find the shortest path in many cases. The average delays in LOCANT reach its minimum faster than the others. With increase in simulation time, all the algorithms except GPSR converge with almost the same lengths and same delay.

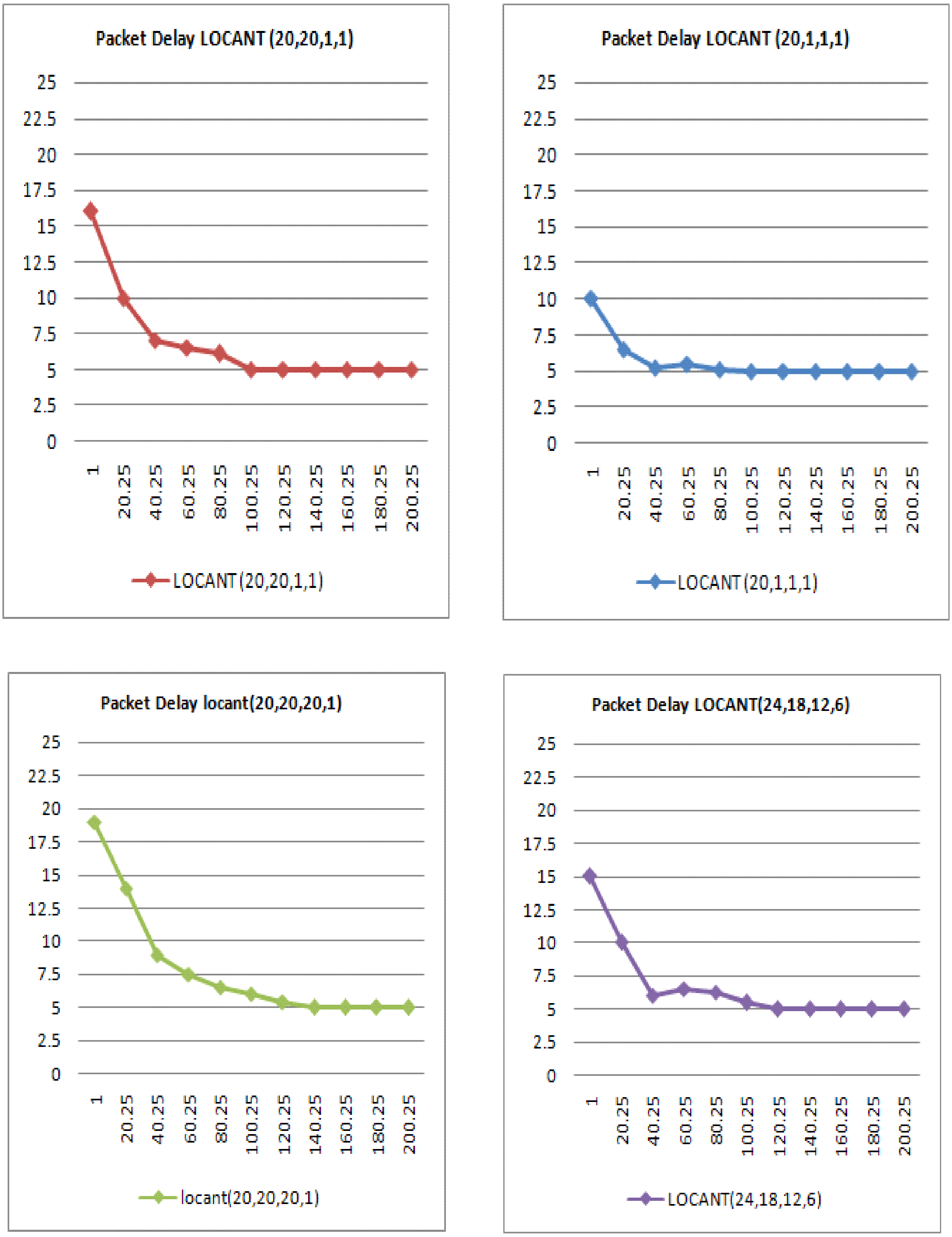


Fig 4 (a) Packet delay of LOCANT

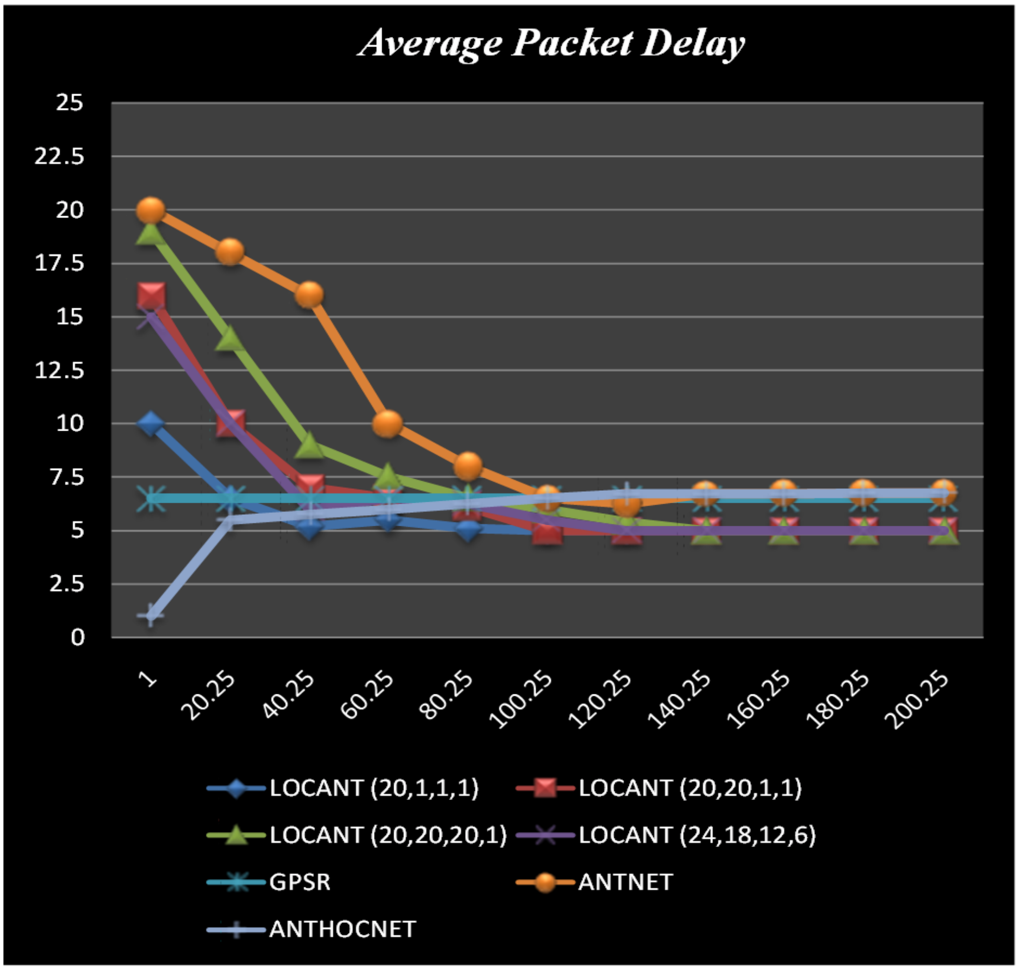


Fig 4 : (b) Average packet delay comparison of LOCANT with GPSR, ANTNET & ANTHOCNET

Algorithm overhead: The number of control messages created and exchanged in the network by each routing algorithm is measured. Table 1 gives the total number of generated ants in LOCANT, ANTNET and ANTHOCNET at different clock times. The total number of ants generated in ANTHOCNET grows exponentially at the beginning while it is a linear function of time in LOCANT and ANTNET. The large number of generated ants in ANTHOCNET to establish a new route makes it useless as a reactive algorithm. Since ants in ANTHOCNET contain a list of the visited nodes, the size of the ant can be relatively large, making the overhead even worse. The number of generated ants in LOCANT and ANTNET is relatively small and it shouldn't affect the network's traffic.

Table: Number of Generated Ants in Different Clock Times

Clock time	0	5	10	20	300
LOCANT	3	14.53	29.33	60.67	768.4
ANTNET	1	5	10	20	300
ANTHOCNET	1	1048	125048	125048	1125048

3. CONCLUSION

On the basis of performance evaluation and comparison with other position based routing algorithms, we conclude that LOCANT doesn’t fail when the network contains nodes with different transmission ranges. Also LOCANT is a multipath routing algorithm and converges to routes which are close in length to the shortest path. The use of location information as a heuristic parameter has resulted in a significant reduction of time needed to establish a route from a source to a destination which is important for a reactive routing algorithm. In addition to having a short route establishment time, LOCANT keeps the number of generated control messages small, unlike ANTHOCNET that uses flooding which makes it unsalable. LOCANT reaches a stable state faster than ANTNET. Thus, LOCANT is a robust, scalable reactive routing algorithm suitable for mobile ad hoc networks with irregular transmission ranges.

REFERENCES

[1] L. Barri`ere, P. Fraigniaud, L. Narayanan, and J. Opatrny. Robust position-based routing in wireless ad-hoc networks with irregular transmission ranges. Wireless Communications and Mobile Computing Journal, pages 141–153, 2003.

[2] P. Bose and P. Morin. Competitive online routing in geometric graphs. Theoretical Computer Science, pages 273–288, 2004.

[3] P. Bose, P. Morin, I. Stojmenovic, and J. Urrutia. Routing with guaranteed delivery in ad hoc wireless networks. Wireless Networks, 7:609–616, 2001.

[4] G. D. Caro, F. Ducatelle, and L. M. Gambardella. Anthocnet: An adaptive nature-inspired algorithm for routing in mobile ad hoc networks. Special Issue on Self-Organisation in Mobile Networking, 16:443–455, 2005.

[5] G. Di Caro and M. Dorigo. Ant colonies for adaptive routing in packet-switched communications networks. In Proceedings of the 5th ACM International Conference on Parallel Problem Solving from Nature, pages 673–682, 1998.

[6] G. Di Caro and M. Dorigo. Two ant colony algorithms for best effort routing in datagram networks. In Proceedings of the Tenth IASTED International Conference on Parallel and Distributed Computing and Systems, pages 541–546, 1998.

[7] M. Dorigo and T. Stutzle. The ant colony optimization metaheuristic: Algorithms, applications, and advances. In Handbook of Metaheuristics, volume 57 of International Series in Operations Research and Management Science, pages 251–258. Kluwer, 2003.

[8] S. Giordano, I. Stojmenovic, and I. Blazevic. Position based routing algorithms for ad hoc networks: A taxonomy. Ad Hoc Wireless Networking, 2003.

[9] M. Gunes, U. Sorges, and I. Bouazizi. Ara - the ant-colony based routing algorithm for manets. In Proceedings of the 2002 International Conference on Parallel Processing Workshops, pages 79–89, 2002.

[10] I. Haque, C. Assi, and J. Atwood. Randomized energy aware routing algorithms in mobile ad hoc networks. In Proceedings of the 8th ACM international symposium on Modeling, analysis and simulation of wireless and mobile systems, pages 71–78, 2005.

[11] P. Jeon and G. Kesidis. Pheromone-aided robust multipath and multipriority routing in wireless manets. In Proceedings of the 2nd ACM international workshop on Performance evaluation of wireless ad hoc, sensor, and ubiquitous networks, pages 106–113, 2005.

[12] B. Karp and H. T. Kung. GPSR: Greedy perimeter stateless routing for wireless networks. In Proc. ACM/IEEE MobiCom conference, pages 243–254, 2000.

[13] E. Kranakis, H. Singh, and J. Urrutia. Compass routing on geometric networks. In Proc. of 11th Canadian Conference onComputational Geometry, pages 51–54, August 1999.

[14] J.-H. Yoo, R. La, and A. Makowski. Convergence results for ant routing. In Proceedings of CISS University of Princeton, Princeton, NJ, 2004.

[15] Shahab Kamali, Jaroslav Opatrny. A Position Based Ant Colony Routing Algorithm for Mobile Ad-hoc Networks. In JOURNAL OF NETWORKS, VOL. 3, NO. 4, APRIL 2008

[16] S. Ziane and A. Mellouk. A swarm intelligent multi-path routing for multimedia traffic over mobile ad hoc networks. In Proceedings of the 1st ACM international workshop on Quality of service and security in wireless and mobile networks, pages 55–62, 2005. JOURNAL OF NETWORKS, VOL. 3, NO. 4, APRIL 2008 41 © 2008

