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Performance Comparison and Evaluation of Ad Hoc Routing Protocols

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Abstract— Mobile ad hoc networks are self configurable where in nodes are mobile and they communicate with each other via wireless connections without fixed infrastructure. Due to the ever changing topology and limited bandwidth it is very difficult to establish and maintain good routes. Even though the traditional routing algorithms are widely used, usually do not meet the expectation in terms of performance. A number of routing algorithms using Swarm Intelligence from the collective behaviour of natural ants have been proposed for MANET. We focused on an adaptive and hybrid routing protocol AntHocNet as it combines the merit of proactive and reactive routing algorithms. In this paper we compare the AnTHocNet, ACO based solution for hybrid ad hoc routing strategy with ad hoc on-demand multipath distance vector (AOMDV) routing protocol and AODV. An attempt has been made by using discrete event simulator NS2 and performance comparison carried with respect to packet delivery ratio, throughput, packet loss and end to end delay. In the simulation results, we observe the adaptability of AntHocNet routing protocol for changing traffic, node and link failures. The performance of AntHocNet significantly better than AOMDV and AODV.

Index Terms— Mobile Ad Hoc Network (MANET), Ant Colony Optimization (ACO), Packet Delivery Ratio (PDR).

1 INTRODUCTION

The Mobile Ad hoc Networks (MANETs) consist of mobile nodes interconnected by multihop communication paths without the fixed network infrastructure. As the ad hoc wireless networks are self-creating, self-organizing and self-administering system, it is used in many applications such as collaborative computing and communications in smaller areas, communications in battlefields and disaster recovery areas. Since the topology of ad hoc networks is unstable and changes frequently with mobility of nodes, traditional routing protocols in static networks are not efficient for ad hoc networks. The major parameters that can be considered for reliable communication are mobility, link stability and route stability. The main sources of unreliability for these applications in MANETs are due to limited battery capacity, limited memory and processing power, varying channel conditions, less stability under unpredictable and high mobility of nodes.

Recently a new family of algorithms emerged inspired by swarm-intelligence, which provides a novel approach to distributed optimization problems. These algorithms show that the biologically inspired concepts can provide a significant performance gain over traditional approaches. The basic idea of the ant algorithm is taken from the food searching behaviour of real ants.When ants search for food, they start from their nest and walk towards the food. When an ant reaches an intersection, it has to decide which branch to take next. While walking ants deposit pheromone which marks the selected route. The concentration of pheromone on a certain path is an indication of its usage. Over time the concentration of pheromone decreases due to diffusion effects. This behaviour of the ants can be used to find the shortest path in networks. Since the route with higher possibility is always favoured, so more ants will pick up that route, and further increase its possibilities and in turn attracts more ants. Due to the use of mobile agents and stigmergy, swarm intelligence boasts number of advantages:

Dynamic topology: This property is responsible for the unfulfilling performances of many classical routing algorithms in mobile ad-hoc networks. The ant algorithms are based on autonomous agent systems imitating individual ants. This allows a high adaptation to the current topology of the network.

Local information: In contrast to other routing approaches, the ant algorithms make use of local information; no routing tables or other similar information have to be transmitted to other nodes of the network.

Link quality: It is possible to integrate the connection/link quality into the computation of the pheromone concentration, especially into the evaporation process. This will improve the decision process with respect to the link quality.

Support for multi-path: Each node has a routing table with

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entries for all its neighbours. Adding the information about the pheromone concentration, the decision rule for selection of the next node could be based on the pheromone concentration at the current node.

Rest of the paper is organized as follows .Section 2 explains the related work. Section 3 describes the AntHocNet algorithm. Section 4 shows the simulation results and section 5 concludes and summarizes the paper.

2 RELATED WORK

There are several routing approaches for MANETs such as DSDV [1], DSR [2], AODV [3].Even though they are widely used, do not meet the expectation in terms of performance. The biologically inspired concept of Swarm Intelligent[4] particularly an Ant colony optimization approach can provide a significant performance gain over traditional routing. The basic idea of the ant algorithm is taken from the food searching behaviour of real ants. The concentration of pheromone on a certain path is an indication of its usage. Over time the concentration of pheromone decreases due to diffusion effects. This behaviour of the ants can be used to find the shortest path in networks. When ants search for food, they start from their nest and walk towards the food. While walking ants deposit pheromone which marks the selected route.

The ACO based routing protocols can be classified as proactive, reactive and hybrid routing algorithms like the traditional routing protocols. The proactive protocol advertises current routing information periodically to all nodes of the network. It may impact route maintenance overhead. The reactive protocol advertises current routing information only at the demand of packet transmission. But, due to high mobility of nodes, the reactive scheme may incur excess delay. To overcome the above problems, researches explore the combination of proactive and reactive approaches to have good trade-off between overhead and latency. There are few works on hybridization of proactive and reactive routing protocols using ant agent like Ant-AODV [5], HOPNET [6], ZHLS [7], Ant-OR [8] and AntHocNet [9].

2.1 EVOLUTION OF ANT BASED HYBRID ROUTING PROTOCOLS

The Hybrid protocol Ant-AODV provides high connectivity which, eliminates the delay before starting the actual communication and increases the throughput. But, the reduction in end-to-end delay and higher connectivity are achieved at the cost of extra processing of the ant messages and the slightly higher overhead. HOPNET is a novel hybrid routing protocol based on Ant Colony Optimization (ACO) and Zone Routing Protocol (ZRP) for Mobile Ad Hoc Networks (MANETs). The path setup process is achieved by intrazone and interzone routing. When a node has data packet for a destination node, it verifies the path availability in inter zone route table. If it does not have route then will start searching new route.

Each node periodically sends an ant in order to maintain and update the intrazone routing table. When number of nodes is small, the continuous movement of peripheral nodes frequently triggers attempts to discover new routes, which causes more overhead and transmission delays compared to other hybrid routing protocols.

Ant-OR is a protocol based on AntHocNet but utilizes distance metric for path exploration and pheromone separation in the diffusion process. It works in two separate modes: Disjoint-link and Disjoint-node; the first corresponds to routes in which nodes are not shared and the latter refers to routes in which links are not shared.

2.2 MULTIPATH ROUTING PROTOCOL AOMDV

Ad hoc on-demand multipath distance vector routing [10] is the multipath extension of single path routing protocol AODV. It has been proposed for finding multiple disjoint loop-free paths during the route discovery phase. In AOMDV, transmission of RREQ from the source towards destination creates multiple reverse paths. Multiple RREPs traverse these paths back to source to form multiple forward paths to the intermediate as well as destination nodes. The availability of multiple paths even in an intermediate node produces less route discovery frequency. As the multipath protocols have higher throughput and less packet loss, AOMDV considered for the comparison.

3 ANTHOCNET ALGORITHM

The AntHocNet is an adaptive and hybrid multipath routing protocol which combines the merit of proactive and reactive routing algorithms. It is an ACO based solution for hybrid ad hoc routing strategy. The main components of AntHocNet are reactive path setup phase and proactive path maintenance phase. The routing information of each node is represented in its pheromone table T^i. Each entry in the route table $\tau^i_{nd} \in R$ represents pheromone value which indicates the estimated goodness of path from node i to destination d over n neighbours. In this algorithm nodes use stochastic routing strategy based on the estimated quality of paths. In this way the data load has been evenly spread. The estimates are kept up-to-date using proactive ants which leads to automatic load balancing. It handles link failures with either local path repair process or through explicit notification messages.

3.1 REACTIVE PATH SETUP

Step 1:When a node S has packet to trasmit towards destination d and no routing information for node d is available, then it broadcasts a reactive forward ant F^s_d.

Step 2: Due to the initial broadcasting, each neighbour of s receives a replica of the forward ant named as ant generation and each of its ant finds a path connecting s and d.

Step 3: If pheromone information is available, the ant chooses its next hop n with probability P_{nd}.

Step4: When a node receives several ants of the same generation, it will forward the ant which travels comparatively less number of hops with minimum travel time estimated as $\hat{T}_P$ and removes other ants to limit the control overhead.

Step 5:Each forward ant keeps a list of the nodes P[1,…n] it

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has visited.

Step 6: When an ant reaches the destination d, it is converted into backward ant.

Step 7:The backward ant computes $\hat{T}_P$ as

$$\hat{T}_P = \sum_{i=1}^{n-1} \hat{T}^i_{i+1}$$

Where $\hat{T}^i_{i+1}$ is the local estimate in each node i ЄP of the time to reach the next hop i+1.

Step 8:The local estimate is calculated by using current number of packets in queue at MAC layer Q^i_{mac} and the estimate of average time to send one packet $\hat{T}_{mac}$ as follows.

$$\hat{T}^i_{i+1} = (Q^i_{mac} + 1)\hat{T}^i_{mac}$$

Step9:the estimate of average time to send one packet $\hat{T}^i_{mac}$ is calculated as

$$\hat{T}^i_{mac} = \alpha \hat{T}^i_{mac} + (1-\alpha) t^i_{mac}$$

Step 10: the pheromone is updated by taking in to account the delay and number of hops.

$$\tau^i_{nd} = \gamma \tau^i_{nd} + (1-\gamma)\tau^i_d, \gamma \in [0,1]$$

$$P_{nd} = \frac{(\tau^i_{nd})^\beta}{\sum_{j \in N^i_d} (\tau^i_{nd})^\beta}, \beta \geq 1$$

3.2 Proactive Path Maintenance

A proactive forward ant for every n data packets is send out by the source node. If the forward ants reaches destination without a single broadcast, it probes an existing path. The backward ant of the correspondence updates the pheromone values of intermediate nodes. On the other hand when an ant got broadcast at any point, it leaves the current known paths and explores new one. Even after a broadcast if the forward ant does not find path within two hops, it is killed.

4 Simulation Result

The experiments have been conducted using network simulator Ns2 to study the characteristics of multipath routing protocol AntHocNet and to compare the performance with AODV and AOMDV.

4.1 Performance Metrics

The performance metrics considered for comparison are :

Packet Delivery Ratio: The ratio of number of packets successfully received to those generated by CBR. The performance is better when packet delivery ratio is high. The PDR gives an idea of how well the protocol is performing at different speeds using different traffic models.

Packet loss ratio: performance metric that measures the fraction of packets lost from the total packets transmitted.

Throughput: is calculated for normalized routing load and is measured in bytes.

End-to-End delay: the time taken by the packet to reach destination. It includes all possible delays such as queuing and propagation delay.

4.2 Simulation Scenario

The simulations are performed with a network of dimensions 1000mx 1000m. Numbers of nodes were varied from 10 to 50 with the node transmission range of 550m.the nodes are allowed to move according to Random Way Point (RWP) pattern. We have used an application protocol Constant Bit Rate (CBR) to send data. The sending rate is 1000 bits/sec that is a packet of 125 bytes with the maximum simulation time up to 50s.

4.3 Result

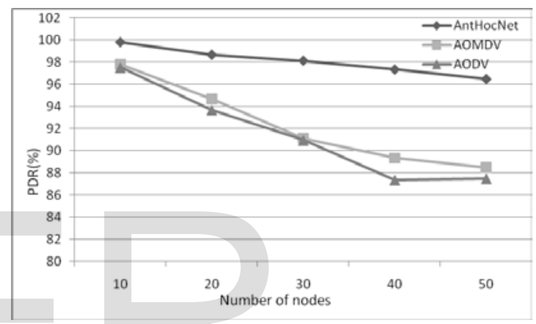

Fig. 1. Number of Nodes Vs PDR

Fig.1 shows the impact of number of nodes on packet delivery ratio. It shows the PDR to maximum when the node is equal to the simulation time. AODV shows the best performance with 97% of packet delivery ratio. AOMDV has approximately the same ratio as AODV for less number of nodes but, in dynamic environment AOMDV has comparable delivery ratio. The AntHocNet has better End-to-End delay than the others.

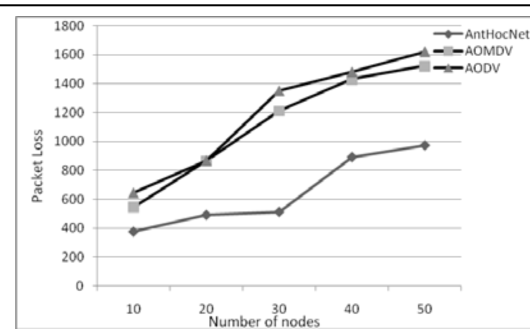

Fig. 2. Number of Nodes Vs Packet loss

From fig.2, it has been observed that the packet drop is more in AODV than AOMDV and AntHocNet. This is due to the availability of single path between the source and destination pair. In AOMDV, being a multipath routing protocol the packet drop is comparably less. In AntHocNet, as a hybrid multipath routing the adaptability to link failure due to dynamic topology is quick in nature which leads to minimum packet drops.

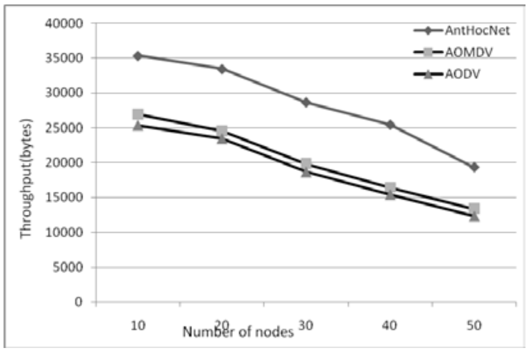

Fig.3. Number of Nodes Vs Throughput

In fig.3 AODV and AOMDV show similar variations of throughput for varying number of nodes. Overall, AntHocNet shows highest throughput and outperforms the other two. The average throughput degrades the performance of large scale networks on account of congestion in the large scale networks.

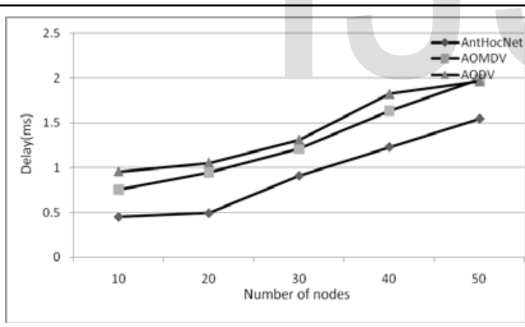

Fig.4. Number of Nodes Vs Delay

The term end-to-end delay does not have much significance in this scenario. The performance of AOMDV is slightly better than AODV especially when the number of nodes cross 30 due to stable maintenance of routing table. AntHocNet produces lower delay due to the fact that it uses different path scheme in the route reply.

5 Conclusion

This paper examines the relative performance of AntHocNet, AOMDV and AODV. The protocols has been analyzed for the metrics PDR, delay, throughput and loss with respect to number of nodes. From the analysis it can be state that AntHocNet, being a hybrid routing protocol outperforms the other reactive routing protocols AOMDV and AODV. AntHocNet effectively utilizes the benefits of proactive and reactive routing strategies. Further the analysis can be carried for other metrics like routing overhead, route discovery frequency.

References

[1] C. Perkins and P. Bhagwat., "Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers",ACM SIGCOMM'94, 1994.

[2] D. B. Johnson and D. A. Maltz., Mobile Computing, chapter Dynamic Source Routing in Ad Hoc Wireless Networks, pages 153{181. Kluwer, 1996.

[3] C. Perkins and E. Royer., "Ad-hoc on-demand distance vector routing", IEEE Workshop on Mobile Computing Systems and Applications, 1999.

[4] Dorigo M., Stützle T., "Ant colony optimization", MIT Press, Cambridge 2004.

[5] X. Zheng, W. Guo, and R. Liu, "An ant-based distributed routing algorithm for ad-hoc networks," in Proceedings of the International Conference on Communications, Circuits and Systems (ICCCAS '04), vol. 1, pp. 412–417, June 2004.

[6] J. Wang, E. Osagie, P. Thulasiraman, and R. K. Thulasiram, "HOPNET: A hybrid ant colony optimization routing algorithm for mobile ad hoc network," Ad Hoc Network, vol. 7, no. 4, pp. 690–705, 2009.

[7] M. K. Rafsanjani, S. Asadinia, and F. Pakzad, "A hybrid routing algorithm based on ant colony and ZHLS routing protocol for MANET," Communications in Computer and Information Science, vol. 120, no. 2, pp. 112–122, 2010.

[8] L. J. G. Villalba, D. R. Ca˜nas, and A. L. S. Orozco, "Bio inspired routing protocol for mobile ad hoc networks," IET Communications, vol. 4, no. 18, pp. 2187–2195, 2010.

[9] G.A. Di Caro, F. Ducatelle, and L.M. Gambardella. "AntHocNet: an adaptive nature-inspired algorithm for routing in mobile ad hoc networks". European Transactions on Telecommunications, 16(5):443–455, 2005.

[10] Mahesh K. Marina, Samir R.Das.,"Ad hoc on-demand multipath distance vector routing", Wireless Communications and Mobile Computing,vol.6, pp 969-988,2006.