Comparative Analysis of Traditional and Adaptive Routing Technique for MANETs in NS2 Environment

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Abstract: Considering energy, network lifetime and the convergence time as main goals, we focus on the biological inspired routing protocol, AntHocNet. In this paper we discuss about the AntHocNet and its comparative analysis with traditional protocol under NS2 environment. Through a series of extensive simulation tests, for different performance metrics, AntHocNet has outperformed the traditional protocol.

Keywords: AntHocNet, Network lifetime, Convergence time, energy, NS2.

Introduction

The perpetual improvement of the technologies related to telecommunication and computer networks is one of the profligate growing aspects of people's needs. The Internet has modernized many aspects of daily life. In fact, it has created the user need and demand to be connected anytime and anywhere. Wireless communication networks have frolicked a perilous role in fulfilling those telecommunication needs.

Wireless ad hoc networks have no fixed infrastructure. In an ad hoc environment there is no central administration to coordinate the data traffic between the participating devices (nodes). Rather, the routing problem has to be solved by the nodes themselves. Due to the increase in the cost, in terms of resource and processing power, of traditional routing methods, the research community has turned its responsiveness to a different approach, put forward to an agent-based networking systems.

Swarm Intelligence (SI) Ref. [6] exemplify the idea that it is possible to control and manage complex systems of agent-like entities, because of multiple interactions with the environment and among themself, they are able to provide solutions to critical problems. This paper emphasis on the agent-based systems that are found in insect societies described as Swarm Intelligence. AntHocNet, an SI-based routing protocol for MANETs based on ant agents is presented.

The rest of the paper is as follows. Section 2 describes the classification of wireless routing protocols. In Section 3, SI-based routing protocol AntHocNet is presented and also the traditional AODV protocols. In Section 4, Simulation environment and the results are described. Finally, the paper concludes with a summary of the experiment results

Classification of Routing Protocols

Routing protocols is a set of rules that a packet must undergo during its journey from the source to sink node in the network. There are different categories of routing protocol viz.

(1) Proactive routing protocol,
(2) Reactive routing protocol and
(3) Hybrid routing protocol.

Figure 1 shows the classification hierarchy of the routing protocol.

Proactive routing protocol

In Proactive Routing Protocol each node has a complete information about the routing to other nodes in the network. The routing information is periodically updated, so that each node as an up-to-date information of the routing.

Reactive routing protocol

In case of Proactive Routing Protocol, even though some of the routes are not active i.e. not currently in use still the entry is made and all the nodes has this entry. This causes the searching time to increase, so Reactive Routing Protocols were developed.

In Reactive Routing Protocol the routes that are currently in use or active will be stored in the routing information at each nodes, whenever a route information is not found, then the packet issues a destination search message to find the appropriate route and the routing is resolved and entry is made at each node.

Figure 1 Classification of routing protocols

Hybrid routing protocol.
As name implies it's a combination of two protocols. These type of protocols are best suited for the network with large number of nodes. Where in it requires both the technique table driven and route discovery mechanism for the better performance.

AntHocNet Routing Protocol

AntHocNet Ref. [4] is a reactive ant colony optimization algorithm. The control packets are used to generate the routing information and also to maintain the path. Source node generates the forward ant agents to find the route to destination, and the destination, upon reception of first forward ant agent packet generates the backward ant agent which follows the same path. To maintain the path reliability the nodes generates the forward ants periodically to the destination. As shown in Figure 2, ants are flooded over the network. Each ant agent's updates the weight of the link with a fixed number called pheromone. Ants that choose shortest path will reach first to the destination. Destination will generate the backward ant agents that follows the same path as the forward agents. This will increase the pheromone value which make the path more reliable. Each node keeps the identity and arrival time of the ants to prevent the infinite loop. Each time when the node is visited by an ant, the identity and the arrival time of the ant is verified with respect to the same generation ants, if it matches then it is forwarded else is discarded. The AntHocNet has its own advantage compared to other SI based protocols, it outperforms in route maintained, energy consumption and convergence time. In this paper AntHocNet is compared with AODV, and simulation results shows that AntHocNet has better performance compared to AODV.

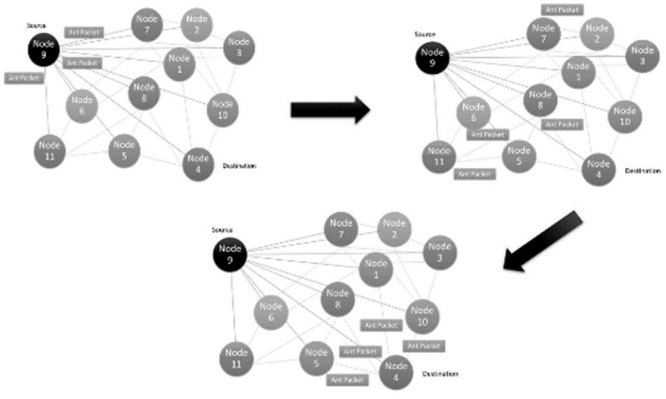

Figure 2. Route Discovery Process in AntHocNet

AODV Routing Protocol

AODV is an on-demand algorithm as it builds routes between nodes only on the request by the source nodes Ref. [2]. One of the advantage is, more than one route or path is identified between any pair of source and destination. It is considered to be the best ad hoc routing protocol based on the following three performance metrics, Packet delivery ratio, Routing overhead, Path optimality. In this paper AODV is compared with a Bio inspired routing protocol called AntHocNet, for certain performance metrics.

Simulation Environment

Table 1 summarize the base ns-2 configuration and set-up for the comparison of the protocols. For 450 sec nodes are moving according to the Random Waypoint model in a network area of 500 X 500. The pause time is varied from 3 to 10 sec. The nodes density in the network is increased in the interval of 20. Initial energy is set for 5 and 20 joules for each nodes. 20 applications are configured in the network. The setup is executed for both AntHocNet and AODV routing protocol.

Table 1 ns-2 configuration and set-up

Number of Nodes	20, 40, 60, 80
Pause Time	3, 5, 10 sec
Initial Energy	5, 20 Joules
Mac	802.11
Dimensions	500 X 500
Simulation Time	450 sec
Routing Protocol	AntHocNet, AODV
sNo of Applications	20

Performance Metrics

1. Packet delivery ratio: This is the fraction of correctly delivered data packets versus sent packets.
2. Throughput: Throughput is the average rate of successful packet delivery over a communication channel.
3. Average end to end delay: Time taken for packet to be transmitted from source to destination.
4. Network Life Time: Time at which the first node dies due to energy drain
5. Energy Consumption: Energy consumed by the overall network
6. Convergence Time: The time between detection of an interface being down, and the time when the new routing information is available.

Simulation Results

Energy Consumption

The figure 3 (a) and 3 (b) shows the energy consumption by the network. The results depicts that as the number of nodes increases in the network the energy consumption of the nodes is less in case of AntHocNet compared to AODV. In figure 3 (a) we can see that there is no significant difference between AntHocNet and AODV as we have given only 5 Joules as initial energy per nodes, but in figure 3 (b) where initial energy per nodes is 20 joules, clearly shows that as the number of nodes increases the energy consumption is reduced significantly in AntHocNet. We can conclude that AntHocNet utilize energy efficiently when the energy levels of the nodes are kept quite high.

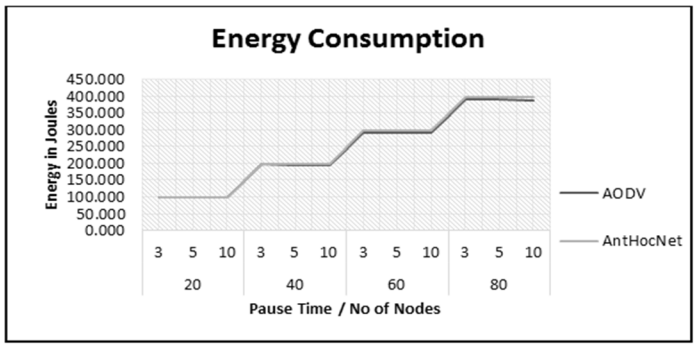

Figure 3 (a) Energy Consumption Initial energy per node 5 Joules

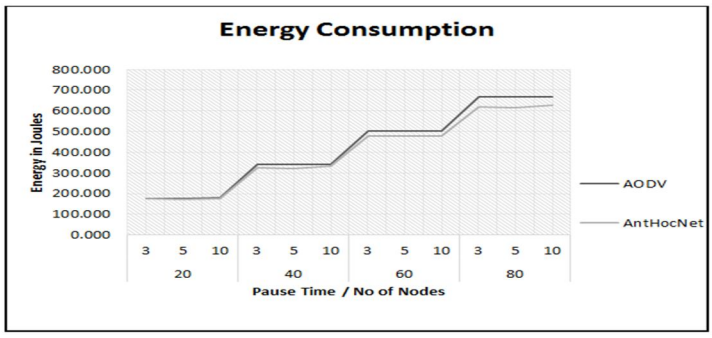

Figure 3 (b) Energy Consumption Initial energy per node 20 Joules

Throughput

Throughput of AODV has outperformed the AntHocNet. In the figure 4 (a) and 4 (b) we can see that when the nodes are less the throughput of AntHocNet is quite good but as the number of nodes increases the performance of AntHocNet with respect to throughput decrease. The throughput in case of AntHocNet degrades as the nodes increases in the network, this is due to more number of hello packets that will be transmitted by nodes in the network, which leads to a considerable delay in generating the routing information during the initial routing step-up.

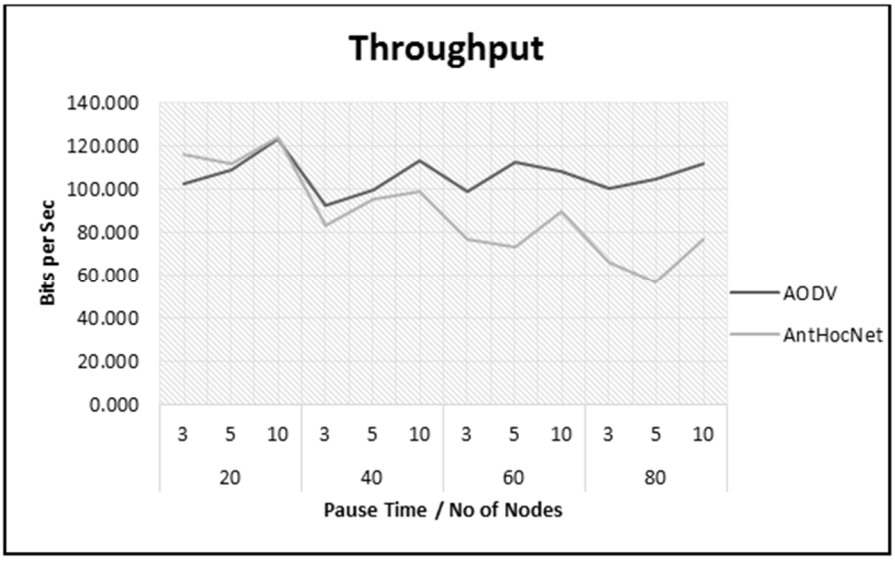

Figure 4 (a) Throughput Initial energy per node 5 joules

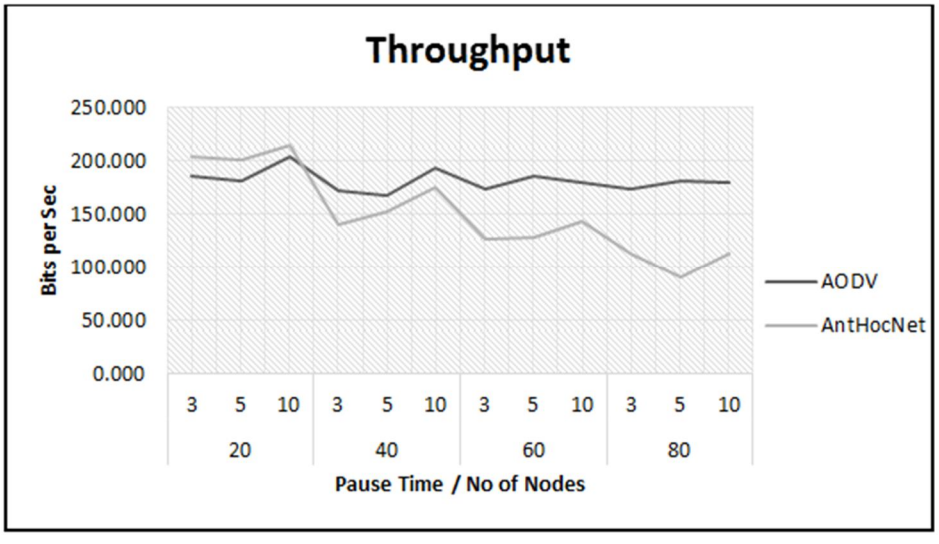

Figure 4 (b) Throughput Initial energy per node 20 joules

End to End Delay

End to end delay is the time interval or delay taken for packet to be transmitted from source to destination. End to end delay must be small enough so that the delivery ratio will be more. In the figure 5 (a) and 5 (b), it's clearly seen that AntHocNet has significantly less end to end delay than the AODV.

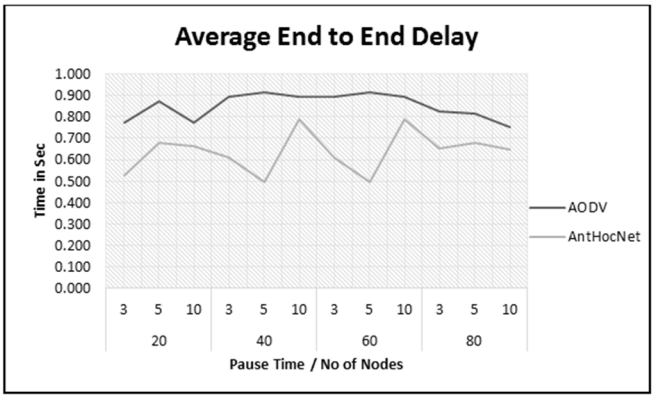

Figure 5 (a) Average end to end delay Initial energy per node 5 joules

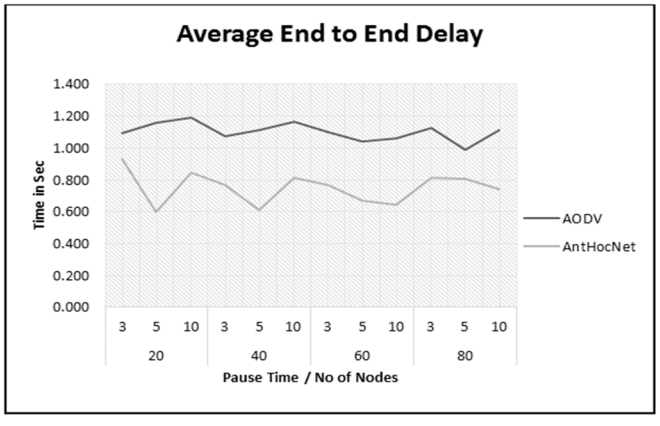

Figure 5 (b) Average end to end delay Initial energy per node 20 joules

Packet Delivery Ratio

Packet delivery ratio is a ratio between the total numbers of packet delivered over the packets sent. In AODV the packet delivery ratio is less, this is due to high mobility and dynamic change in the network topology. Where as in case of AntHocNet the packet delivery ratio is quite good compared to AODV, this is due to the protocol, AntHocNet is an hybrid routing protocol it uses both proactive and reactive approach, in case of any failure in the network or the path by using these approaches it stabilizes the routes quickly using the reactive and proactive ant agents (both forward and backward). The figure 6 (a) and 6 (b) shows the packet delivery ratio of both the protocols, the AntHocNet has outperformed the AODV

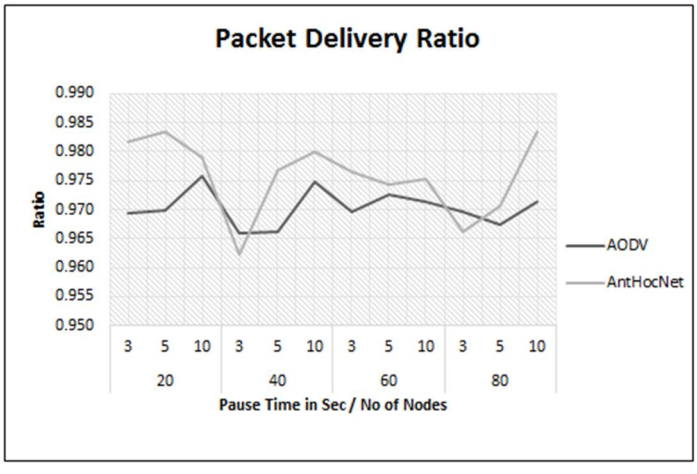

Figure 6 (a) Packet delivery ration initial energy per node 5 joules

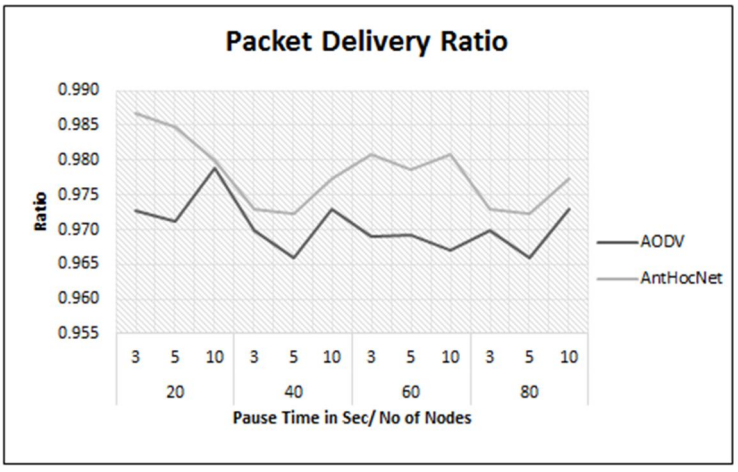

Figure 6 (b) Packet delivery ration initial energy per node 20 joules

Network Life Time

Network life time is the time at which the first node in a network gets deactivated due to full utilization of the energy by that node. Higher the network life time better the utilization of energy by the network. In the figure 7 (a) we can see that for the less number of nodes in the network both AODV and the AntHocNet has considerably equal network life time, but the change can be seen as the number of nodes increases in the network. AntHocNet has a higher network life time compared to AODV when the number of nodes increases.

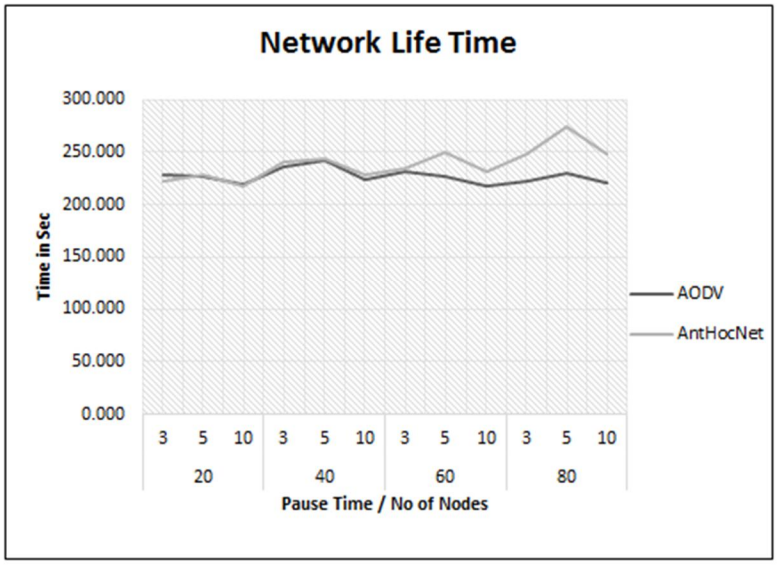

Figure 7 (a) Network time Initial energy per node 5 joules

Convergence Time

Convergence time Ref. [8] has been defined as the time between detection of a link failure and the time take to find a new routing information between the source and the destination. This is a significant concern for mobile networks as, the high mobility and frequent change in the network topology is one of the basic requirements of a MANET routing protocol. The convergence time is measured for all route - failure - route rediscovery cycles, and the average is considered to be the convergence time of that algorithm. The figure 8 (a) and 8 (b) shows the average convergence time of the AODV and AntHocNet routing protocol. From the figure we can say that AntHocNet has high convergence time for few instance this might be because of delay or drop of the reactive error ant agents, but when considering the overall convergence time AntHocNet has outperformed the AODV. This is due to proactively keep on updating the link or path information periodically by sending PRFA and PRBA (ant agents). In the figure 8(a) we can see that for the higher nodes there is no convergence time that means no link failure, the same can be seen in figure 8 (b) also.

Network Life Time Vs. Energy

Now we are comparing both the network life time and energy consumption. We say that network life time depends on the node which completely utilizes its energy and dies first in the network. Here we compare both AODV and AntHocNet protocol with respect to their network lifetime and energy consumption. In the figure 9 (a) we can see that the energy consumption in case of AntHocNet is more compared to AODV, this might be due to number of transmission that AntHocNet might have done, even though energy consumption is more in AntHocNet, network life time has not been reduced, but in case of AODV even though energy consumption is less the network life time is as also less. We conclude that for any network the network life time should be more, by considering this aspect we say that AntHocNet has outperformed the AODV with respect to network life time.

Throughput Vs. Packet Delivery Ratio

Throughput is the average rate of successful packet delivery over a communication channel for a period of time. Whereas Packet delivery ratio is the fraction of correctly delivered data packets versus sent packets. In the network goal is to achieve higher throughput and a better packet delivery ratio. In this we compare the throughput and packet delivery ratio of AntHocNet and AODV protocol. Fromm the figure 10 (a) and 10 (b), it is derived that AntHocNet has a better packet delivery ratio event though less through put. Whereas AODV has a better throughput than the packet deliver ratio.

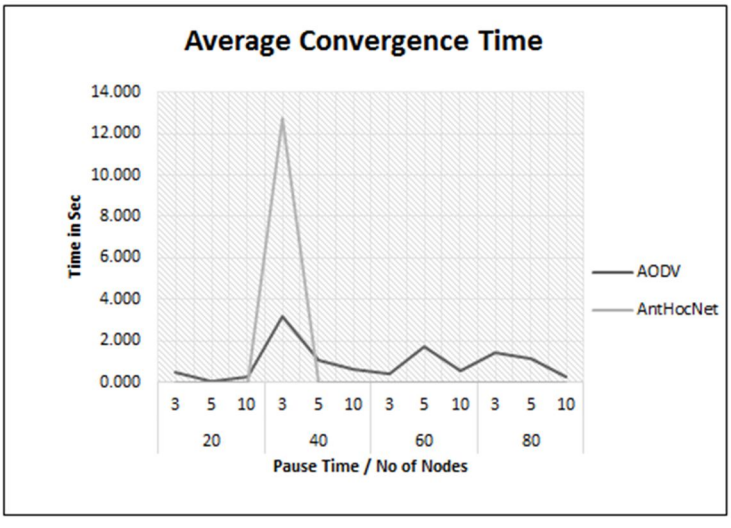

Figure 8 (a) Average convergence time Initial energy per node 5 joules

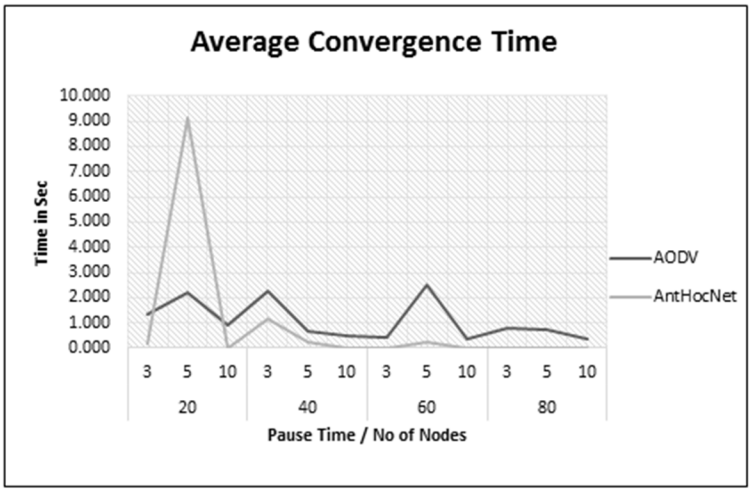

Figure 8 (b) Average convergence time Initial energy per node 20 joules

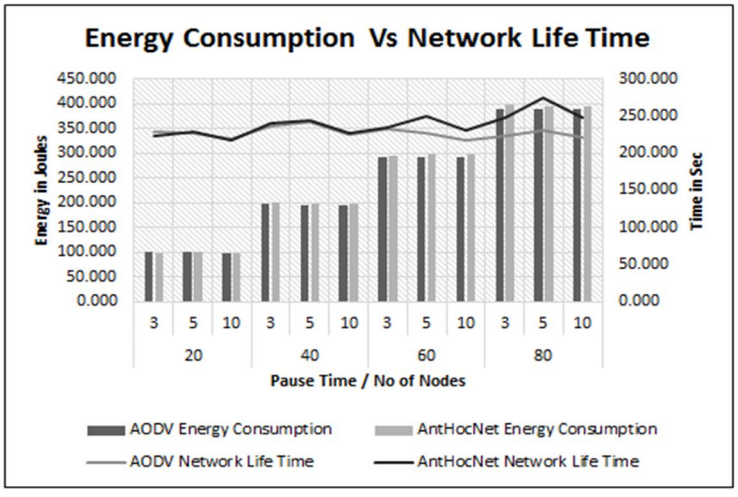

Figure 9 (a) Energy consumption Vs. Network life time Initial energy per node 5 joules

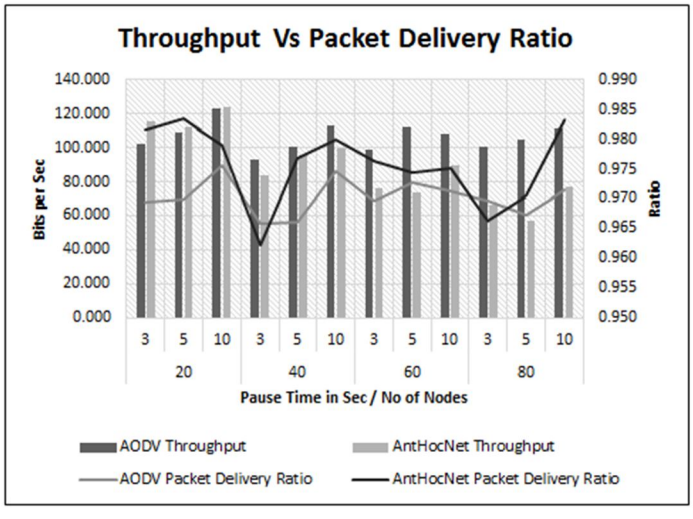

Figure 10 (a) Throughput vs. Packet delivery ratio Initial energy per node 5 joules

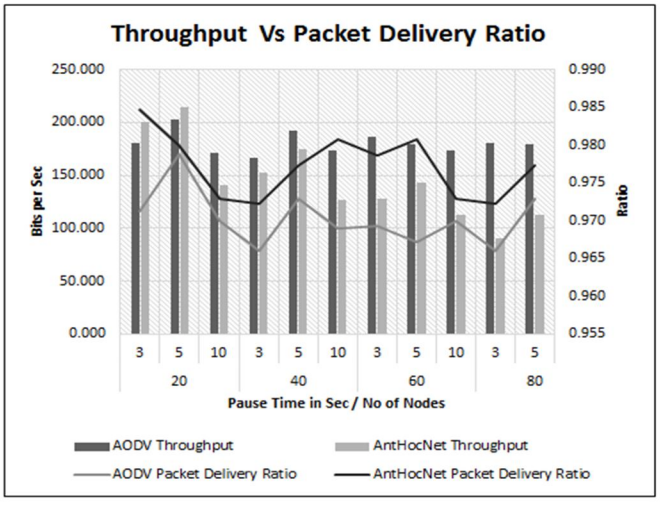

Figure 10 (b) Throughput vs. Packet delivery ratio Initial energy per node 20 joules

Conclusion

This paper emphases on the agent-based systems in insect societies. AntHocNet an SI-based routing protocol for MANETs is presented. Further the classification of routing protocol for wireless network (MANETs) has been described. With as extensive set of test cases we compared the protocols with different performance metric. In case of network life time, packet delivery ratio, end to end delay and convergence time the AntHocNet has outperformed the traditional AODV protocol. Likewise AODV as outperformed the AntHocNet with respect to throughput. When overall energy consumption is considered AntHocNet has outperformed the AODV.

Acknowledgement

The successful completion of any task would be incomplete without acknowledging those who made it possible and whose guidance and encouragement made the effort put-forth, a success. It gives me immense pleasure to avail this opportunity to thank Dr. N V R Nadiu, the Principal, MSRIT. I owe heartfelt gratitude to Head of the department of CSE, Dr. Anitha Kanavalli, for her support and encouragement. I would like to express gratitude to my mentor Dr. Annapurna P Patil without whom completion of this work would not be possible. I also thank Neeraja R Menon, for her constant and timely support and encouragement.

References

[1] Federic Ducatelle “Adaptive Routing in Ad Hoc Wireless Multi-hop Networks

[2] C. Perkins and E. Royer, “Ad hoc on-demand distance vector routing”, In Proc. of the 2nd IEEE Workshop on Mobile Computing System and Application(WMCSA), San Juan, pp. 90–100.

[3] S. Basagni, I. Chlamtac and V. Syrotiuk, “Dynamic source routing for ad hoc networks using the global positioning system”, In Proc. of the IEEE Wireless Communications and Networking Conference(WCNC’99), New Orleans LA, pp 21–24.

[4] F. Ducatelle, G. Caro and L. Gambardella, “Anthocnet: An adaptive nature- inspired algorithm for routing in mobile ad hoc networks”, Self-Organization in Mobile Networking, vol. 16, no. 5, pp. 443–455.

[5] S.-J. Lee, E. M. Royer, and C. E. Perkins. Scalability study of the ad hoc on-demand distance vector routing protocol. ACM/Wiley International Journal of Network Management, 13(2):97–114, 2003.

[6] Alexandros Giagkos, Myra S. Wilson, “BeeIP – A Swarm Intelligence based routing for wireless ad hoc networks” Information Sciences 265 (2014) 23–35

[7] Annapurna P Patil, Dr K Rajani kanth , BatheySharanya, M P Dinesh Kumar, Malavika J, “Design of an Energy Efficient Routing Protocol for MANETs based on AODV” Vol. 8, Issue 4, No 1, July 2011

[8] Annapurna P Patil, N Sambaturu, K Chunhaviriyakul “Convergence time evaluation of algorithms in MANETs” arXiv preprint arXiv:091