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AN EVALUATION STUDY OF ANTHOCNET

Soni Shaik [1], P. Chenna Reddy [2]
[1]P.G student, J.N.T.U.A College Of Engineering Pulivendula, INDIA, soni.it07@gmail.com
[2]Professor, J.N.T.U.A College Of Engineering Pulivendula, INDIA, pcreddy1@rediffmail.com

ABSTRACT

Ad-hoc wireless multi-hop networks (AHWMNs) are communication networks that contain wireless nodes created without prior planning. All the nodes have routing capabilities and forward data packets for other nodes in multi-hop fashion. AHWMNs pose various types of challenges to routing protocols than more traditional wired networks. AHWMN routing protocols are categorized as topology-based, bio-inspired and position-based routing protocols. This paper does the performance evaluation of AntHocNet which is based on the ant foraging behavior. It is based on Ant Colony Optimization (ACO) metaheuristic. Along with Ad-hoc on demand distance Vector (AODV) routing protocol and Dynamic Source Routing (DSR) protocol by using the network simulator ns-2.34 at different pause times, different speeds, different number of nodes and also at different data rates.

Key words : AHWMN, AntHocNet, AODV, DSR.

1. INTRODUCTION

Ad hoc wireless multi-hop networks (AHWMNs) [1] are a collection of mobile devices which form a communication network with no pre-existing infrastructure. Routing in AHWMNs is challenging since there is no central coordinator that manages routing decisions. Routing is the task of constructing and maintaining the paths that connect remote source and destination nodes. This task is particularly hard in AHWMNs due to issues that result from the particular characteristics of these networks. First important issue is the fact that AHWMNs are dynamic networks. This can be because of their ad hoc nature: connections between nodes in the network are set up in an unplanned manner, and are usually modified while the network is in use. An AHWMN routing algorithm should be adaptive in order to keep up with such dynamics. A second issue is unreliability of wireless communication. Data and control packets can easily get lost during transmission, especially when mobile nodes are involved, and once multiple transmissions take place simultaneously and interfere with one another. A routing algorithm should be robust with respect to such losses. A third issue is caused by the often restricted capabilities of the AHWMN nodes. There are limitations in terms of node processing power, battery power, memory, network bandwidth, etc. It is therefore important for a routing algorithm to work in an efficient way. Finally, last important issue is the network size. With the ever growing numbers of portable wireless devices, several AHWMNs are expected to grow to massive sizes. Routing algorithms should be scalable to keep up with such evolutions. Biology does provide solutions to scalability. Computer network is one engineering field which has many parallels with biology and hence the solutions of biology can be used to solve the problems of computer networks. Although the Internet is perhaps the world's newest large-scale, advanced system, it's certainly not the only one. Definitely the oldest large-scale, advanced systems are biological.

Biological systems are evolving over billions of years, adapting to an ever-changing environment. Swarm intelligence is that the property of the system whereby the collective behaviors of unsophisticated agents interacting locally with their environment cause coherent functional global patterns to emerge. Swarm intelligence provides a basis with which it is possible to explore collective problem solving without centralized control or the provision of a global model. Ants show their collectiveness in finding the food source. A group of ants indirectly communicate by just modifying the environment. No direct communication between them takes place. All the ants work towards global objective of collecting food. Common goal is more important than any individual goals. They optimize their behavior to achieve the common goal.

2. MANET PROTOCOLS

In the following subsections we discuss the most commonly used standard routing protocols AODV and DSR along with AntHocNet.

2.1Ad hoc On-Demand Distance Vector (AODV)

AODV [2] routing algorithm is a routing protocol designed for ad hoc mobile networks. It is an on demand algorithm, which means that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources. Additionally, AODV forms trees that connect multicast group members. The trees are composed of the group members and the nodes needed to connect the members. AODV uses sequence numbers to make sure the freshness of routes. It's loop-free, self-starting, and scales to large number of mobile nodes. AODV is a combination of both DSR and DSDV. It borrows the essential on demand mechanism of Route Discovery and Route Maintenance from DSR, and also the use of hop-by-hop routing, and sequence numbers, periodic beacons from DSDV.

2.2Dynamic Source Routing

DSR [2] is a simple and efficient routing protocol designed specifically to be used in multi-hop wireless ad hoc networks of mobile nodes. DSR permits the network to be completely self-organizing and self-configuring, without the need for any existing network infrastructure or administration. DSR is a reactive routing protocol that uses source routing to send packets. It uses source routing which means that the source must know the complete hop sequence to the destination. As in other reactive algorithms, nodes only actively look for routing information when it is strictly needed, i.e. when data needs to be sent to a destination for which no valid route exists. Important features of the algorithm are that it uses source routing, and that it makes extensive use of caching to increase the available routing information.

2.3AntHocNet

AntHocNet [3] [4] is a multipath routing algorithm that combines both proactive and reactive components. The algorithm is reactive in the sense that it only gathers routing information about destinations that are involved in communication sessions. It is proactive in the sense that it tries to maintain and improve information about existing paths while the communication session is going on. Routing information is stored in pheromone table. Forwarding of control and data packets is done in a stochastic way, using these tables. Link failures are dealt with using specific reactive mechanisms, such as local route repair and the use of warning messages.
In AntHocNet routing information is organized in pheromone tables. Every node i maintains one pheromone table Ti that might be a two-dimensional matrix. An entry Tdij of this pheromone table contains the information about the route from node i to destination d over neighbor j. This information includes the pheromone value Tdij , which is a value indicating the relative goodness of going over node j when traveling from node i to destination d, additionally as statistics information regarding the path, and possibly virtual pheromone. Apart from a pheromone table, every node also maintains a neighbor table, in that it keeps track of which nodes it has a wireless link to.

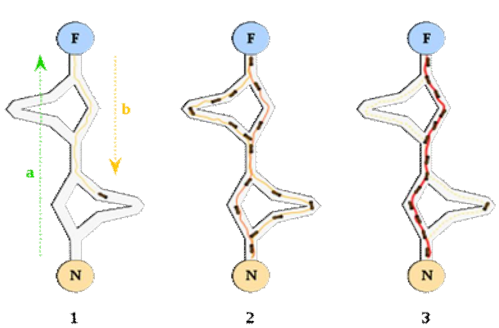

Figure 1: Ants in nature

3. SIMULATION ENVIRONMENT

To test and compare the performance of AntHocNet protocol, the network simulator NS-2 [5], version 2.34 is used. The network model used in our simulation is composed by mobile nodes and links that are considered unidirectional and wireless. Each node considered as communication endpoint is host and a forwarding unit is router. In addition to NS-2, a set of tools, mainly Bash scripts and AWK filters, to post-process the output trace files generated by the simulator are developed. In order to evaluate the performance, multiple experiments were set up.

4. PERFORMANCE METRICS

Different performance metrics are used in the evaluation of routing protocols. They represent different characteristics of the overall network performance. The metrics considered are routing overhead, packet delivery ratio and Average end-to-end delay.

Packet Delivery Ratio: This is the ratio of total number of packets successfully received by the destination nodes to the number of packets sent by the source nodes throughout the simulation.

Average End-to-End Delay: This is defined as the average delay in transmission of a packet between two nodes.

Routing Overhead: Routing overhead is the total number of routing packets.This metric provides an indication of the extra bandwidth consumed data traffic.

5.RESULTS AND ANALYSIS

The following results show the Packet Delivery Ratio and Routing Overhead of AntHocNet, AODV and DSR at different pause times, speeds, Data rates and Number Of nodes with UDP as transport protocol.

a. Varying Pause times:

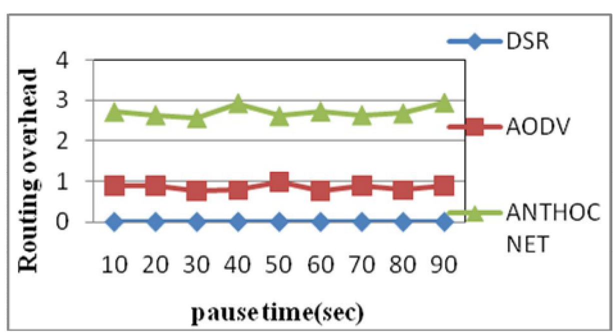

Figure 2: Routing overhead for DSR, AODV and AntHocNet to varying pause times

From Figure 2, it is clear that AntHocNet has more routing overhead than AODV and DSR.

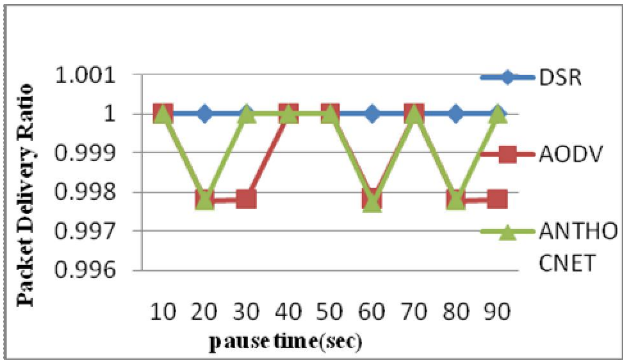

Figure 3: Packet delivery ratio for DSR, AODV and AntHocNet.

From Figure 3, we observe that when pause time is increased up to simulation time, AntHocNet outperforms AODV, but DSR gives best results than AntHocNet. This is due to decrease in node mobility as pause time is increased.

b. Varying Speeds

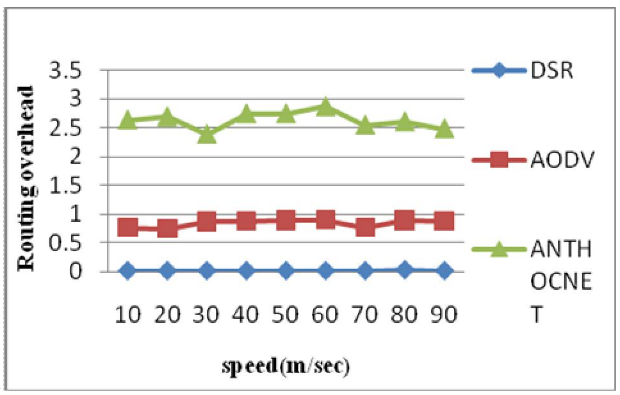

Figure 4: Routing Overhead for DSR, AODV and AntHocNet

From Figure 4, it is clear that AntHocNet has more routing overhead than AODV and DSR. This is due to reactive and proactive route maintenance of AntHocNet.

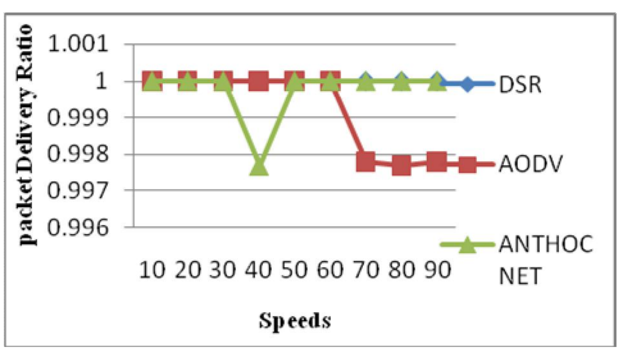

Figure 5: Packet Delivery Ratio for DSR, AODV and AntHocNet

From Figure 5, it is clear that at higher speeds AntHocNet has better performance than AODV, because when speed is increased network becomes more dynamic.

c. Varying Data rates:

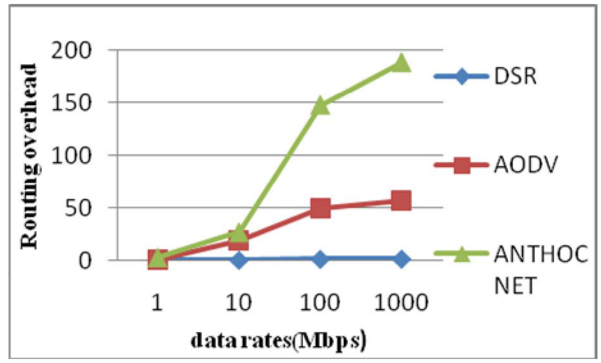

Figure 6: Routing Overhead for DSR,AODV and AntHocNet.

From figure 6, it is clear that AntHocNet has more routing overhead than AODV and DSR. This is due to reactive and proactive route maintenance of AntHocNet.

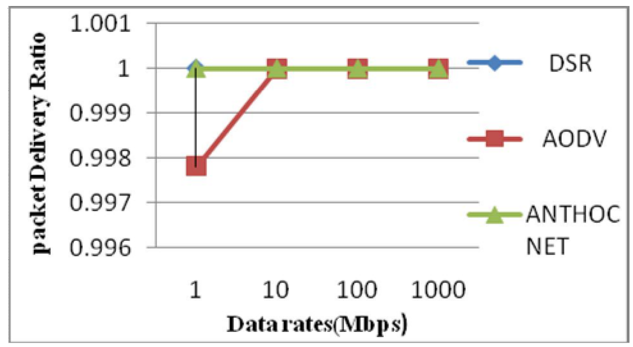

Figure 7: Packet delivery ratio for DSR, AODV and AntHocNet.

From Figure 7, it is clear that all three protocols give similar results when data rate is increased.

d. Varying Number of Nodes:

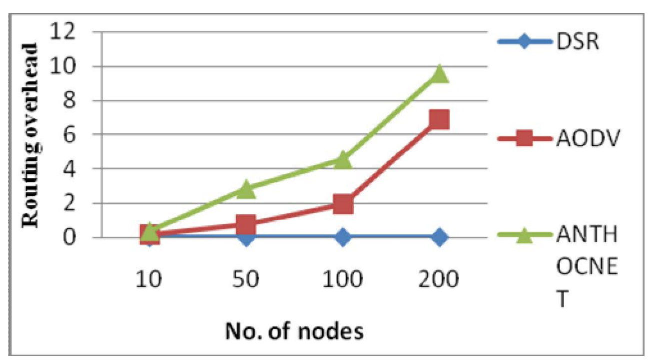

Figure 8: Routing Overhead for DSR, AODV and AntHocNet.

From Figure 8, it is clear that AntHocNet has more routing overhead than AODV and DSR. This is due to reactive and proactive route maintenance of AntHocNet.

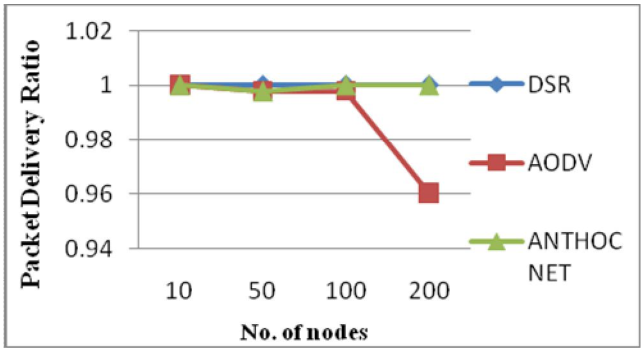

Figure 9: Packet Delivery Ratio for DSR, AODV and AntHocNet.

From Figure 9, we are observe that when number of nodes increased AntHocNet has more packet delivery ratio than AODV and similar results are obtained with DSR.

The following results show the Packet Delivery Ratio and Routing Overhead of AntHocNet, AODV and DSR at different pause times, speeds, Data rates and Number Of nodes using TCP.

a. Varying pause times:

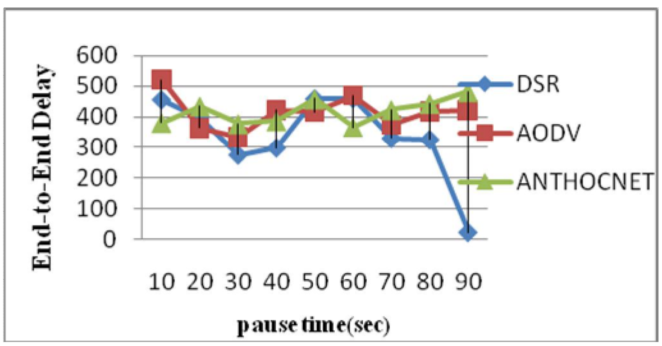

Figure 10: End-to-end delay for DSR, AODV and AntHocNet

From Figure 10 , it is clear that average end to end delay in AntHocNet is high compare to AODV and DSR because in TCP route maintenance overhead is high.

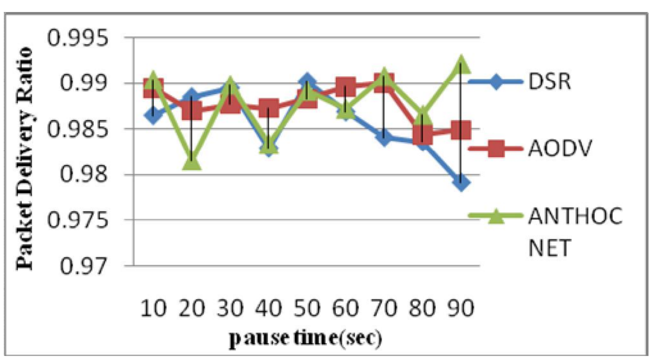

Figure 11: Packet Delivery Ratio for DSR, AODV and AntHocNet

From Figure 11, packet delivery ratio is very high in AntHocNet compare to AODV and DSR because, In TCP AntHocNet follows proactive and reactive algorithms.

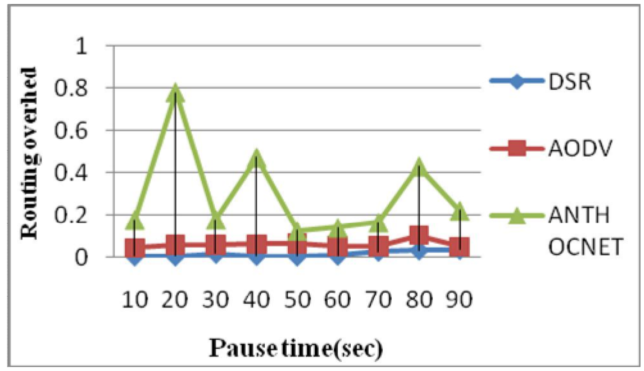

Figure 12 : Routing Overhead for DSR, AODV and AntHocNet

From Figure 12, it is clear that AntHocNet has more routing overhead than AODV and DSR. This is due to reactive and proactive route maintenance of AntHocNet.

b. Varying Speeds

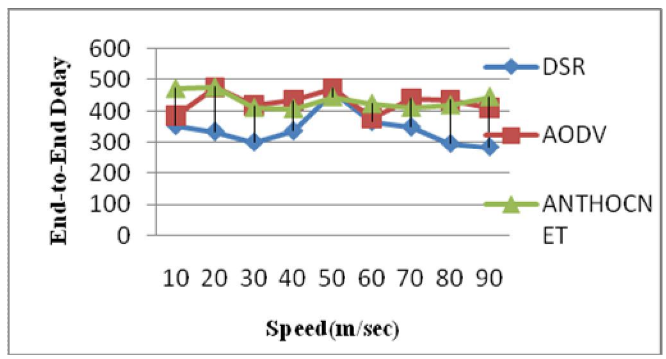

Figure 13: End-to-end delay for DSR, AODV and AntHocNet

From Figure 13, it is clear that end to end delay for AntHocNet in TCP is high when comparing with both DSR and AODV.

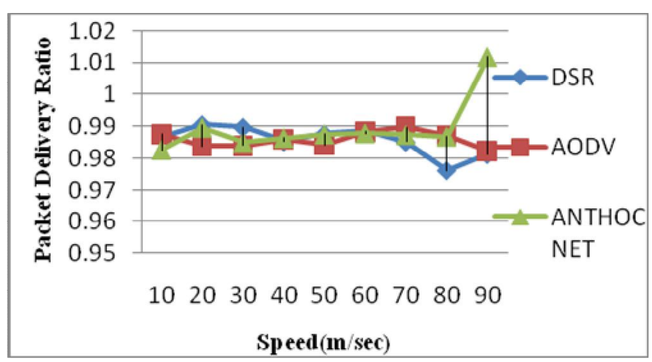

Figure 14: Packet Delivery Ratio for DSR, AODV and AntHocNet

From Figure 14 , we observe that the packet delivery ratio is very high compare to AODV and DSR because in TCP AntHocNet follows proactive and reactive algorithms.

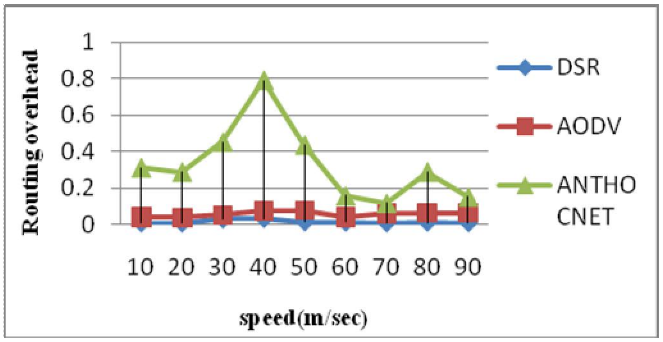

Figure 15: Routing Overhead for DSR, AODV and AntHocNet

From figure 15, it is clear that AntHocNet has more routing overhead than AODV and DSR. This is due to reactive and proactive route maintenance of AntHocNet.

6. CONCLUSION

The performance of AntHocNet is compared with the routing protocols AODV and DSR by using the performance metrics such as packet delivery Ratio, end-to-end delay and Routing overhead. From the results it can be concluded that AntHocNet has higher performance at higher data rates, at higher number of nodes, higher pause times, and at higher speeds with UDP as transport protocol. The performance of AntHocNet is getting high gradually while increasing the data rates and number of nodes in the network, and also the performance of AntHocNet is inferior while increasing speed and pause times. When TCP is the transport protocol, performance of AntHocNet is better than AODV and DSR at different pause times and at different data rates where as in routing overhead point of view the performance of DSR is better than AODV and AntHocNet at different pause times and speeds.

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