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Comparative Analysis of AntHocNet, AODV, DSR Routing Protocols for Improvising Loss Packet Delivery Factor

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***Abstract*— Adhoc wireless multi hope networks are increasing in popularity, because of use of low cost wireless networking solution has enabled wide variety of application and services available in laptops, cellular phones, sensor devices, PDAs and embedded system etc., provides ubiquitous access to information. In Adhoc wireless multi hope networks these devices will communicate directly with each other without relying on any infrastructure. Thus, Adhoc networks are highly vibrant and self-configuring. Routing is a task of forwarding packets from source to destination over any kind of network i.e. wired or wireless. Routing is one of the major issues in computer network literature. For Adhoc networks complexity of routing increases because of dynamic and unplanned network topology, no centralized authority, varying quality of service requirement etc., from the inherent unreliability of wireless communication, from the limited resources availability like bandwidth, battery etc. and from the possibly large scale of these networks. Many routing protocols have been proposed to increase efficient data transfer among different mobile appliances in Adhoc network environment. These protocols have proactive, reactive and hybrid mechanism. AntHocNet is adaptive nature inspired on demand routing algorithm for Adhoc networks which will be highly adaptive, efficient, scalable and it mainly reduces lost package ratio in high mobility cases.**

Main aim of this paper is to simulate and analyse the dynamic performance of AntHocNet routing protocol with IEEE 802.11 MAC protocol in random way point model using NS2. Performance of AntHocNet is compared with two reference routing algorithm like Adhoc Online Distance Vector (AODV) and Dynamic Source Routing (DSR) algorithm. All results have been analysed based on lost packet ratio and normalized routing overhead by varying number of nodes, for different pause time and for different speed.

***Keywords*— AODV, DSR, AntHocNet, Loss Packet Ratio, Performance, AHWMNs, Routing.**

I. INTRODUCTION

Nowadays, the use of low cost wireless networking solution has enabled a wide variety of applications and services available in laptops, cellular phones, PDAs, Embedded systems, provide ubiquitous access to information. Adhoc network plays a major role in this area, as any host may act as a relay point and communicate with other host without requiring a fix infrastructure, which exchange existing video coverage area. This type of network is suited for use in situations where fix infrastructure is not available, not trusted, too expensive or unreliable. Possible scenarios include, but are not limited to; emergency and rescue operations, conference or campus settings, temporary headquarters or military operations.

In spite of this growing interest in Adhoc networks, a generalized dissemination of the technology is still constrained by the practical restriction due to limited medium bandwidth and highly variable quality of transmission path. In addition the mobile, multi hope nature also possess other problems such as nodes can move freely and dynamic nature of topology.

To support this new communication paradigm, robust, reliable and efficient algorithms are needed to allow network to offer a good or at least unacceptable level of service. Hence, routing is one of the primary functions; each node has to perform in order to have fully functional network. Routing in such type of networks is major research issue and many proposals have appeared within its scope. Some of them result from the adaptation of classical routing algorithm, for wired network. However, as the challenges in Adhoc network are there of much complex, new approach are needed to overcome the difficulties [1] [4].

II. RELATED RESEARCH

Adhoc routing protocols can be categorized in the following two classes depending on the way they find routes: proactive and reactive routing protocols. Proactive routing protocol or table driven routing protocol attempt to have at all times an up to date route from each node to every possible destination. This requires the continuous propagation of control information throughout whole network in order to keep routing table up to date and have consistent view of network topology. Proactive routing protocols defer in type and number of routing tables and the way in which topology changes are broadcasted [5] [6].

While reactive protocols are also called as on demand routing protocols, only setup a route when required. Node start with route discover phase by broadcasting route request within the network when source require path to the destination. Then the route maintenance procedure is used by the source to keep active routes up to date as long as it required. In case of link failure route repair procedure may be started. Different reactive routing protocols differ in terms of the strategy to deal with route maintenance and route repair [5] [6]. Hybrid routing protocol try to combine proactive and reative mechanism to reduce protocol overhead. Position based routing protocol use geographic information to optimize routing process. A hierarchical protocol such as clustering protocols introduces hierarchy in the network in order to reduce overhead and improves scalability.

By taking a quite different approach, insect societies [1] have become source of inspiration for routing. As it can be easily observed, real ants can converge on the shortest path that connects their nest to source of food. This behaviour is caused by chemical substance, pheromone: while moving, the ants deposit the pheromones and tend to follow the paths with the highest intensity of pheromones. The path attracts more ants will experience an increasing level of pheromones, until the majority of the ants converge on the shortest path. This indirect form of communication used by ants which modify the environment and react to this modification is known as Stigmergy. By modelling the ant's behaviour routing agents and data packets can act as artificial ants leaving pheromone trail as they pass through path between the source and the destination.

III. METHODOLOGY

AntHocNet [1] [2] is a hybrid, adaptive routing algorithm which utilizes both reactive and proactive routing. It combines a reactive route setup and proactive path maintenance and improvement process. The way in which AntHocNet gathers stores and uses routing information is inspired by Ant Colony Optimization approach to routing and from distance vector routing. Routing information is stored in Pheromone Table which is used for forwarding of control and data packets. This forwarding is done in a stochastic way. Pheromone Table contains details like regular pheromone value, virtual pheromone value and average hop number for destination over neighbor node.

One more table is also maintained by each node called as neighbor table. Neighbor Table contains details like neighbor node and last recent time at which node heard periodic message from that neighbor node. AntHocNet working involves following main phases.

A. *Reactive Route Setup*

This phase is started when node receive data from user through user application for particular receiver. Node first start search into its pheromone table to see whether routing information for intended receiver is available or not. If it doesn't, sender starts this phase by constructing and broadcasting Reactive Forward Ant (RFA) packet over the network in order to find route towards destination.

Now each intermediate node when receive RFA packet then they either broadcast or unicast it, depending upon whether they have routing information in its pheromone table for particular intended receiver. Due to this broadcasting RFA can spread quickly over network with different copies of ant following different paths to destination. In order to limit overhead, nodes only forwards first copy of RFA which they receive and subsequent copies are simply discarded by intermediate nodes.

Once RFA is reached to destination, it converts into Reactive Backward Ant (RBA). This RBA is unicasted from destination to source by using same path which RFA followed but in reverse direction. While moving RBA will updates tables i.e. pheromone table stored at intermediate node. This phase ends with setup of single route between source and destination.

B. *Proactive Route Maintenance Process*

This is proactive module of algorithm which updates, extends and improves available routing information in their respective table. Proactive means this will be executed continuously not based on any trigger condition. This will help to handle link failure immediately, which reduces packet loss. It consists of two sub-phases: Pheromone Diffusion and Proactive Ant Sampling.

1) *Pheromone Diffusion*:

This sub-phase uses periodic update message and information bootstrapping in order to spread all pheromone information. Pheromone Diffusion is executed by all nodes throughout their lifetime, and not bounded to running session.

Each node in network will broadcast "Hello", a periodic message after every t_{hello} seconds. Each node spread the routing information i.e. pheromone information of their neighbor through this hello message. When any node receive this hello message they will makes entry of that details into their pheromone table by updating virtual pheromone value only. Once this virtual pheromone entry is stored, proactive ant samples this if it better. And afterwards only this path will used to forward data packet.

2) *Proactive Ant Sampling:*

Aim of this sub-phase is to sampled better paths of current communication session, if any. This sub-phase is executed as long as session is going on. In this Proactive Forward Ants (PFA) are generated and periodically scheduled by source node towards destination. PFA may follow a path represented by either regular pheromone value or virtual pheromone value, whichever is better. First case is simply updation of existing path. Latter one will result into exploration of new path. Once PFA reaches to the destination, node will convert into Proactive Backward Ant (PBA). Now destination will unicast this PBA towards source by using same path which PFA followed but in reverse direction. This PBA updates pheromone table of intermediate nodes and source also. This updating means PBA may change virtual pheromone into regular pheromone, if its better and sample this more reliable virtual pheromone path. Afterwards this new better sampled path will be used for data forwarding.

C. *Data Packet Forwarding*

In hop-by-hop manner data packets are forwarded from source to destination. Routing decision is taken at every intermediate node by using reliable path which is represented by regular pheromone value only. These reliable paths are the one which are sampled by ant packets.

D. Link Failures

This consists of two sub-phases that is link failure detection and link failure handling. Link failure is detected by node using two ways. First is, when ACK from higher MAC layer is not received. Second way is, if node doesn't receive periodic update hello message from their neighbor for couple of t_{hello} seconds.

Once failure is detected, in order to handle link failure one of mechanism is used like broadcasting link failure notification message, local route repair method, or unicasting warning messages.

In case of link failure notification technique, node removes entries from their table correspond to that failed node and then construct notification message. Notification message include failed node and also better routing information i.e. pheromone value if they have. Node will now broadcast this message to their neighbor. When neighbor receive this message they react in same way that first node did. Neighbor node will removes entry respective to that failed node from their pheromone table and construct and broadcast notification message.

In local route repair technique, node will not broadcast notification message to their neighbor instead it try to repair path towards destination locally by constructing and broadcasting Route Repair Forward Ant (RRFA) and unicasting Route Repair Backward Ant (RRBA). This broadcasting is limited up to two hop count neighbor node only. Aim of this is to search path towards destination which is around and nearer to original path between source and destination.

In unicast warning message, if higher layers doesn't support broadcast of notification message due to network overloading, then node will construct and unicast small size warning message to their neighbor for link failure notification.

IV. Experimental Methodology & Characteristics Of Simulation Environment

Simulation has been carried to evaluate performance on network when number of nodes, pause time, and speed are varied. Various parameters are considered for simulation are listed in following Table-I.

TABLE I
NETWORK PARAMETERS DEFINITION

Channel Type	Channel/WirelessChannel
Radio-Propagation model	Propagation/TwoRayGround
Network Interface Type	Phy/WirelessPhy
MAC Type	Mac/802_11
Interface Queue Type	Queue/DropTail/PriQueue
Antenna Model	Antenna/OmniAntenna
Max Packet in ifq	50
Number of Mobile Nodes	25, 50, 75, 100
Grid Size(X x Y)	800 x 400, 1500 x 1300, 1800 x 900, 3000 x 1500
Routing Protocol	AntHocNet, AODV, DSR
Packet Size	512 Bytes
Simulation Time in sec.	300, 500, 700, and 900 s
Energy in Joules	10000

V. Results, Performance Evaluation And Analysis

Experiments are carried out in NS2 [9] with programming in Tool Command Language (TCL). Two output files are generated after running tcl program i.e. *.nam and *.tr which were further analysed. Nam is a TCL/TK based animation toll for viewing graphical network simulation topology and real world packet transmission. It shows logical layout of network topology, animation at packet level and data inspection tools. Trace files are analysed by AWKs script. Finally graph of various parameters are shown with GNU Plot tool. Performance of routing protocol is evaluated by taking number of nodes, pause time, and speed as a parameter and then result of AntHocNet are compared with two reference routing protocol i.e. AODV and DSR.

A. Generating Traffic and Mobility Models

To carry out our experiments we have to generate traffic and also have to make mobility models and for this FTP traffic sources are used. The source-destination pairs are spread randomly over the network. Traffic models were generated for 25, 50, 75 and 100 nodes with FTP traffic sources at a rate of 8kbps. (Rate 2.0: in 1 second, 2 packets are generated. The packet size is 512 byte. Therefore the rate is $2 \times 512 \times 8$=8kbps). The packet sending rate in each pair and the number of source-destination pairs is varied to change the offered load in the network.

The mobility model uses here is the random waypoint model in a rectangular terrain area with the field configurations used is 800 *X 4*00 m^2 with 25 nodes, 1500 *X 1*300 m^2 with 50 nodes, 1800 *X 9*00 m^2 with 75 nodes and 3000 *X 1*500 m^2 with 100 nodes. Here, each packet starts its journey from a random source to a random destination. Another random destination is targeted after a pause once the destination is reached. Here for the experimental purpose we keep the varied pause time which affects the relative speeds of the mobiles. We have taken different pause time such as 0, 10, 20s .we also have taken different speeds as 0 m/s, 10 m/s, and 20 m/s. Identical mobility and traffic models generated only once to gather fair results for this project. To generate large number of nodes and their positions and movements including moving directions & speeds we have used a CMU tool called "setdest" in ns-2. Following figure shows one of simulation run's output with 100 nodes.

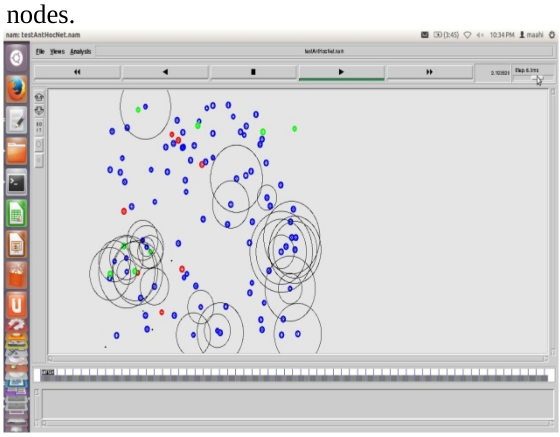

Fig. 1 Simulation Setup for AntHocNet

B. Performance Metrics

We have focuses on two performance metrics such as Loss-Packet-Ratio (LPR) and Normalized Routing Overhead.

1. Loss Packet Ratio: This is the ratio of total number of loss packets to the number of packets sent by the source nodes throughout the simulation.

2. Normalized Routing Overhead: This is the ratio of total number of routing packets by total number of packets which are received successfully by destination. This metric provides an indication of the extra bandwidth consumed.

VI. SIMULATION RESULT AND DISCUSSION

Even though AntHocNet, AODV and DSR share a similar on demand behavior but differences in the protocol mechanism can lead to significant performance differentials. The performance differentials are analysed using loss packet ratio, normalized routing overhead (NrOH) with respect to varying speed and pause time and number of nodes.

TABLE II
LOSS PACKET RATIO AND NORMALIZED ROUTING OVERHEAD ANALYSIS FOR VARYING SPEED

Speed	AntHocNet	
	LPR	**NrOH**
10	0.8483	2.034168
20	1.1499	2.488832
30	1.2465	3.070511
40	1.284	3.057588
50	2.3406	3.697713
AODV		
10	3.168	0.737099
20	4.5786	1.065762
30	3.6013	1.051574
40	4.0962	0.978101
50	5.2297	1.298183
DSR		
10	0.761	1.114901
20	1.5205	2.149316
30	1.4019	2.921517
40	1.8632	4.296166
50	2.14	6.726605

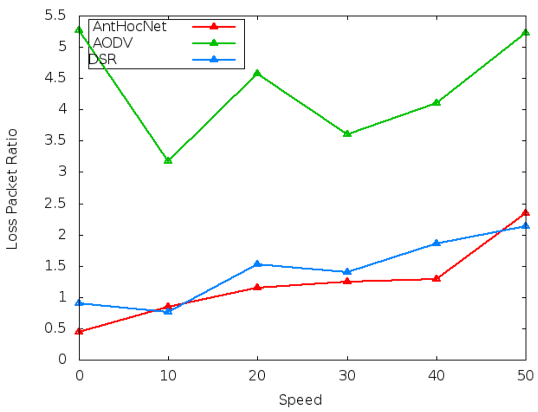

Fig.: Loss Packet Ratio vs. Speed

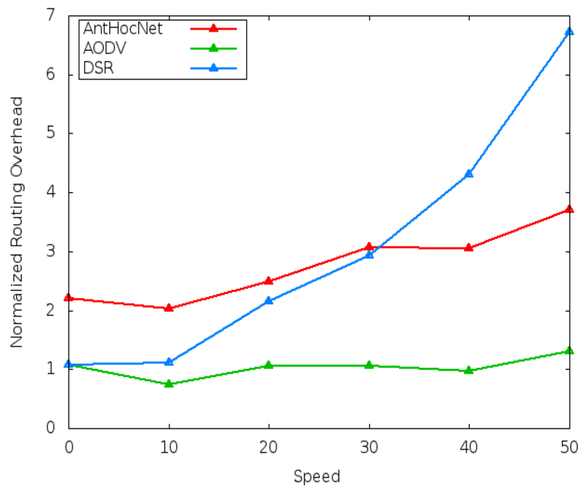

Fig.3: Normalized Routing Overhead vs. Speed

TABLE IIII
LOSS PACKET RATIO & NORMALIZED ROUTING OVERHEAD ANALYSIS FOR VARYING PAUSE TIME

Pause Time	AntHocNet	
	LPR	**NrOH**
0	0.7622	2.952562
10	1.1421	2.199549
20	0.9908	1.803047
30	1.1636	1.874277
40	0.7099	1.272978
AODV		
0	2.7426	1.009696
10	3.8622	0.818414
20	3.1916	0.977434
30	3.4514	1.004931
40	2.1752	0.720364
DSR		
0	0.9306	1.118415
10	0.8174	0.954029
20	1.1518	0.887671
30	1.0083	0.747687
40	0.5695	0.494004

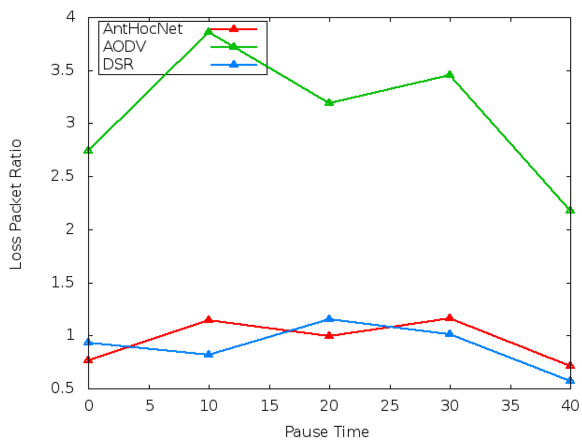

FIG. 4: LOSS PACKET RATIO VS. PAUSE TIME

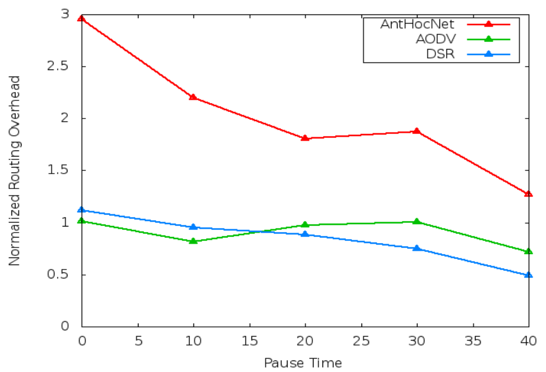

Fig. 5: Normalized Routing Overhead vs. Pause Time

TABLE IIIV
LOSS PACKET RATIO & NORMALIZED ROUTING OVERHEAD ANALYSIS FOR VARYING NO. OF NODES

No. of Nodes	AntHocNet	
	LPR	**NrOH**
25	0.9006	0.688211
50	1.2077	2.399531
75	1.4581	4.610169
100	0.1061	1.355077
AODV		
25	2.4675	0.200353
50	3.9626	1.069503
75	3.6827	1.903904
100	1.1045	0.269363
DSR		
25	1.5567	0.067952
50	1.1131	1.442783
75	0.9788	2.723043
100	0.2272	0.334068

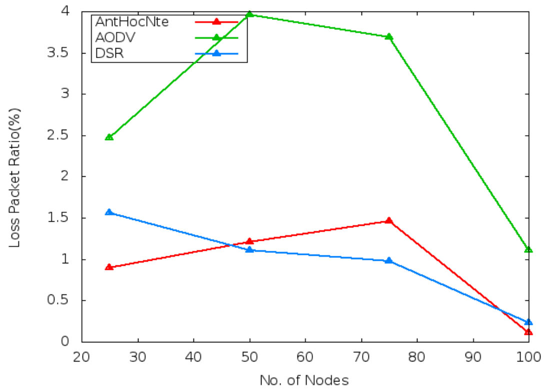

Fig. 6: Loss Packet Ratio vs. Number of Nodes

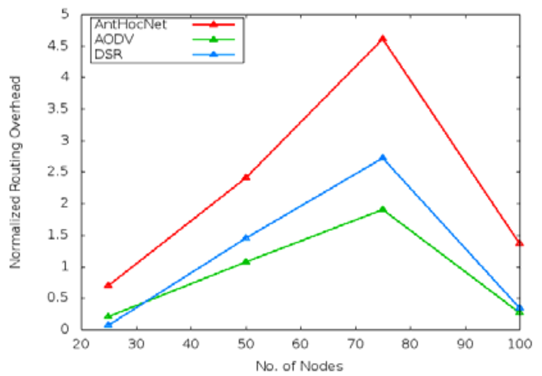

Fig. 7: Normalized Routing Overhead vs. Number of Nodes

Figure 2, 4, and 6 shows comparison of loss packet ratio for varying speed, pause time and number of nodes respectively. AntHocNet is relatively lower, consistent and stable as compared to the DSR and AODV.

Figure 3, 5, and 7 shows comparison of normalized routing overhead for varying speed, pause time and number of nodes respectively. AntHocNet has normalized routing overhead is higher than AODV and DSR. Thus AntHocNet is consistent and stable as compared to AODV and DSR as number of nodes and speed increases.

VII. Conclusion

Scalability of AntHocNet in comparison with classical routing algorithm AODV and DSR is demonstrated by simulation results. AntHocNet performs better in terms of loss packet ratio at high rates, at large number of nodes, and with high mobility. Its performance is inferior to DSR at low rates and at less number of nodes in terms of normalized but superior than DSR & AODV in many scenarios in terms of normalized routing overhead. From this it is concluded that AntHocNet is suggested for large-scale, high data rate networks with high mobility. As number of nodes increases or at high rates also, the AODV's and DSR's performance either decreases or very low whereas AntHocNet's performance either constant or increases with either increase in number of nodes or at high data rates.

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