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Traffic Investigation of AntHocNet with Varying Mobility

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Abstract—Routing is a major concern in Mobile Ad Hoc Networks. Multi-path routing offer a good solution to route failure problems in MANET by making alternate routes available. AntHocNet is a hybrid routing protocol which apply reactive mechanism to set up a communication path and apply proactive mechanism to maintain and discover alternate routes. The AntHocNet routing protocol is inspired by swarm intelligence [1]. It is based on the principals of Ant colony optimization.Through this paper we try to investigate the AntHocNet performance with varying mobility. The routing protocol performance is analyzed for CBR and TCP traffic. Simulator ns-2 is used for simulation. This investigation shows that due to the application of two phases for route formation and maintenance the route discovery frequence is reduced.

Keywords— AntHocNet, Mobile Ad Hoc Network, Traffic analysis, Multi-path Routing protocol, Quality of Services

I. INTRODUCTION

Routing is a vital element of any network. The Key to a good routing mechanism is network topology. Since topology in Mobile Ad Hoc Networks (MANET) is dynamic, routing becomes a key challenge. MANET nodes move at will and their movement is unpredictable. This increases the routing challenges in MANETs. The Dynamic Nature of MANET, not only make routing complex but it turns out to be a barrier in achieving desired Quality of Services. MANET routing protocols are categorized on the basis of time of route discovery. First is Proactive routing where the route discovery process is carried out periodically irrespective of whether the route is required or not. Every MANET node sends its routing information to other nodes from time to time. The routing information received from all nodes is used to construct network topology at the receiving node. This intermittent route formation requires lot of control information transmission to happen in the network. Adding more control overheads. Second is Reactive routing where the route formation takes place if there is a need for a route or existing route fails and a new route is required. The later has many advantages over the former. Therefore Reactive routing is more popular than Proactive routing [2,3,4,5,6] .

As mentioned earlier in MANET node movements are unpredictable and hence route failure probability is more. Every time a route fails, a new route discovery process has to be activated in reactive as well as proactive routing. This put in additional control overheads in routing process.

Many routing protocols for MANET are proposed that combines functionality of both proactive and reactive routing. They form a third category of routing protocols and called as Hybrid Routing Protocols. Hybrid routing protocols try to take up better things and omit drawbacks of proactive and reactive routing [7].

This paper is an attempt to investigate MANET hybrid routing protocol AntHocNet. This investigation focuses the performance analysis of AntHocNet with varying mobility.

Rest of the paper is structured as follows. Following section provide details about AntHocNet. Simulation setup details are given in next section. There after the simulation results and analysis are discussed.

II. ANTHOCNET

AntHocNet is a multi-path routing algorithm for MANET. It is based on the principals of Ant Colony Optimization (ACO) [8]. It is hybrid algorithm that consists of both reactive and proactive components. The AntHocNet routing algorithm works in two phases; reactive path setup and proactive path maintenance and exploration. [9,10].

A. *The Reactive Path Setup*

In Reactive path setup routes are discovered on demand i.e. when a source node (s) requires a communication route to destination d the route discovery procedure is started. The Source node s broadcast reactive forward ant F^s_d. These reactive forward ants are similar to route request packets of Ad Hoc Multi-path distance vector routing protocol (AOMDV) [11]. When the reactive forward ant is received by an intermediate node, it looks for pheromone entry for the requested destination in its pheromone table. The pheromone entry for d in node's (intermediate) pheromone table is the value indicating estimated goodness of going from s to d via intermediate node n. If n do not have any entry in its pheromone table with respect to the requested destination it (re) broadcast the ant. Because of this broadcasting the reactive ants quickly propagate in the network. This increases the chances of receipt of duplicate ants at nodes. All the duplicate ants are discarded. At the destination only the first received ant is processed. The first ant received at destination d is converted into reactive backward ant. This reactive backward ant set up the path from s to d by updating the routing table in intermediate nodes along its way back to the source s.

Following is the algorithm for reactive path setup in AntHocNet

1. Node s demands a communication route to the destination d.
2. s broadcast Reactive Forward Ants F^s_d.
3. Check F^s_d for duplicate
   If duplicate discard
   Else goto 4.
4. At each intermediate node n looks for pheromone entry for d in its pheromone table T^i .
   a) if no pheromone information available broadcast F^s_d
   b) if pheromone information is available, F^s_d choose its next hope n with probability **$P_{nd} = (T^i_{nd})/\Sigma_{j\in N^i_{jd}} T^i_{nd}$** (eq. 1)

   N^i_{jd} is the set of neighbors of i over which a path to d is known.

5. First F^s_d received at d is converted into reactive backward ant that setup path from s to d by tracing *p* = [1,2…d] (list of nodes visited by F^s_d before reachingd d).

The reactive backward ants update the intermediate node's routing table by calculating local estimate of time at each node. At node i€ *p* and i<d the ant calculate time required by an ant to reach the neighbor i+1, T^i_{i+1}. This estimate is used to calculate estimate of time required for an ant to reach from i to d, T^i_d and in turn s to d, T^s_d.

$$T^i_d = \sum_{i \le n < d,\ n \in p} T^n_{n+1}$$

Through this process when the ant reach s the full path is setup and now its ready for communication. The data packets can be sent on the discovered path [9,10,12,13,14].

B. Proactive Path maintenance and exploration

The proactive path update phase is useful in maintaining paths set up in the reactive path set up phase. This phase proactively improves the existing path. At some point in communication session the source node bring into play proactive forward ants to update the information about the currently used paths to the destination, and tries to find alternate paths. This Proactive mechanism is achieved with the bootstrapped information in the form of hello messages. The hello messages are periodically broadcasted. These are short messages broadcast every t_{hello} seconds by the nodes (e.g. t_{hello} = 1 sec). If a node k receives hello message from a node j, k assumes that j is its neighbor and expects to receive hello message from j every t_{hello} seconds. If k misses certain number of hello messages from j (e.g. 2 hello messages), it assumes that j is no longer its neighbor.

While broadcasting, the node construct the hello message by including routing information it has about active destinations. The node obtains information about active destinations from its pheromone table. If there are many active destinations at a node, it randomly selects number of destinations (e.g.10). When a node k receives the *hello message* from j, it will check if it has an entry for destination d over neighbor j. If there is no entry, it is an indication of a possible new path from k to d over j. If it has entry for d but over other intermediate node it is hint of potential alternate path to d. To build hello message the node consult its pheromone table and put together its bootstrapped pheromone value which is indicated as an alternative pheromone to the regular pheromone constructed on the reactive phase by the reactive backward ants. This virtual pheromone is placed in the Virtual Pheromone Routing Table to avoid mixing the regular pheromone values with virtual ones and create routing loops. Each node compares their regular pheromone with virtual pheromone. The regular pheromone is changed by the bootstrapped one if the virtual pheromone is considerably better than the regular one. In case if a node hasn't got any routing information for a destination and if it is available in the bootstrapped one, then this information will be used and a new route to the destination is activated. Proactive forward ants are unicast and uses values in Virtual Pheromone routing table as much as possible. If there is no entry in Virtual pheromone routing table, then only the regular pheromone table is used to make its way to the destination. At a node where there is no information available for destination d in both the tables, the proactive forward ant is simply discarded. The proactive forward ant chooses next hop using the eq.1. The proactive forward ant is converted into proactive backward ant when it successfully reaches the destination and it traces back the intermediate nodes it visited to the source and at the same time it removes the entries from the virtual pheromone table into the regular pheromone routing table [9,10,12,13,14]. Both the reactive path setup and proactive path maintenance phases create paths between the source and destination. Now using the pheromone table entries, the data is forwarded [10]. The next section provide detailed simulation setup followed by results and discussion.

III. SIMULATION SETUP

AntHocNet is simulated using network simulator-2 (ns-2) version 2.34 [15] with 802.11 MAC protocol as wireless channel. Both CBR and TCP traffics are simulated for the protocol. Table1 gives the detailed simulation parameters used.

In our simulation 100 nodes are placed randomly in the 1000 m X 1000 m area. Multiple numbers of sources and destinations are used. Random Waypoint mobility model is used for node mobility. When mean node speed varies, the packet rate is set to 1 packets/s and 50 numbers of connections are used. AntHocNet performance is analyzed with respect to CBR and so also with TCP traffic. For each node speed the simulation run time is set to 200s. Data Packet size was set to 512 bytes.

TABLE I :SIMULATION PARAMETERS

Parameter	**Values**
Topology Size	1000 X 1000
No of Nodes	100
No of Sources	Multiple
NO of Destinations	Multiple
Packet Size	512
MAC Protocol	IEEE 802.11
Simulation Time	200s
Traffic Types	CBR/TCP
Simulation run	200s for each mean node speed
Packet rate	1.0
Number of connections	50
Mean node speed	1, 2.5, 5, 7.5, 10

IV. RESULTS AND DISCUSSION

Fig.1 to Fig.4 shows effect of mobility on different QoS for AntHocNet with respect to CBR and TCP traffic. The throughput decreases with increase in mobility for both type of traffic. It is evident that the throughput decreases because of higher mobility. With increase in node mobility probability of a node of going out of range is more and therefore the route failure probability increases. This turn out to be a main reason behind reduction in throughput. Due to increase in node movement the average delay in AntHocNet is reduced with both type of traffic. The investigation shows that the routing overheads are more with higher mobility. It is easy to make out from the graphs that the routing overheads and route discovery frequency shows increase with increasing mobility. This is happening because of proactive path update, in which the alternate paths are created that adds up into the overheads. The periodic control packets i.e. the hello messages are mainly responsible for this. The alternate routes discovered in this phase are available for use in the event of route failure; a new route discovery happens only if all available routes fail. Similar is the case for drop packet ratio for both types of traffic. As the node mobility increases chances of dropping more packets increases. We are able to find that the mobility certainly affects the protocol performance.

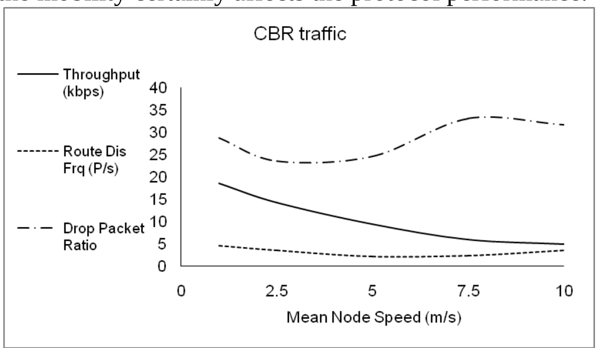

Fig.1 cbr-Throughput,Route Dis Frq,Drop Packet ratio

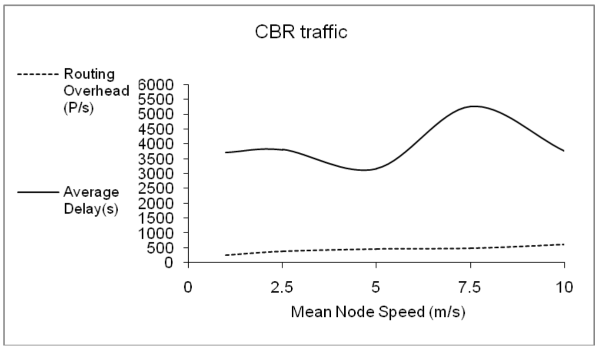

Fig.2 cbr-Routing Overhead, Average Delay

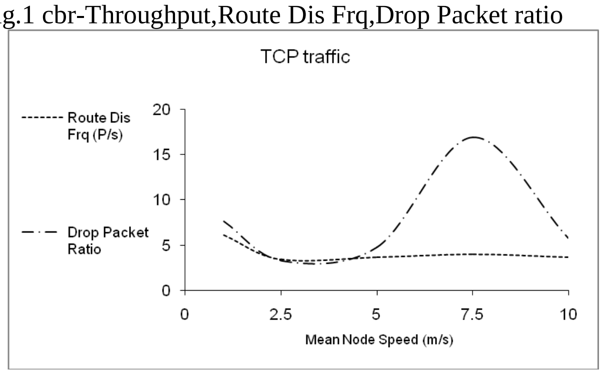

Fig.3 tcp-Route Dis Frq,Drop Packet ratio

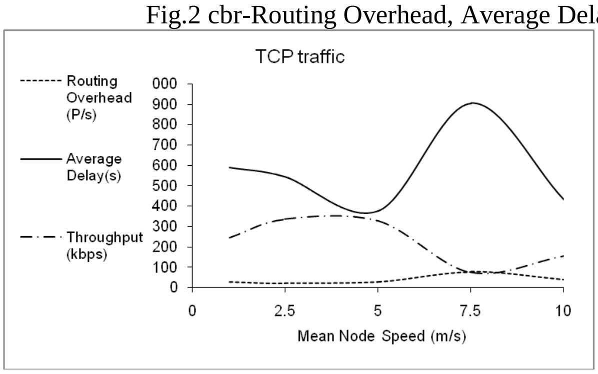

Fig.4 tcp-Routing Overhead, Average Delay,Throughtput

Now we provide the analysis of effect of average delay on different quality of service parameters with varying mobility. Here also both traffic types are evaluated. As the delay between packet deliveries at nodes increases it is obvious that the nodes may presume that a route failure is there and may start route repair, this will add up into the overheads. The routing overhead issues mainly will be more in real time applications as their delay tolerance is less. It is apparent from Fig.5 and Fig.6 that the throughput achieved by the protocol is not affected by the average delay. The packet dropping ratio will increase with increase in average delay. This mainly is of concern in real time applications.

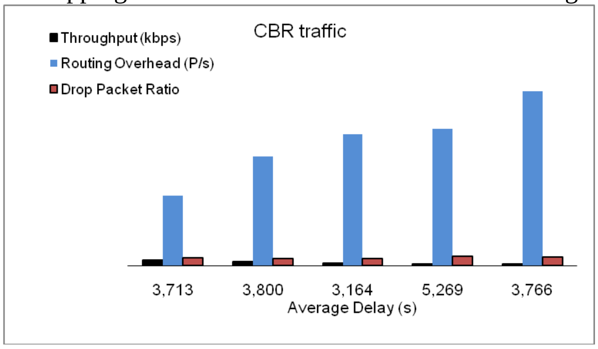

Fig.5 Qos with respect to Average Delay for cbr traffic

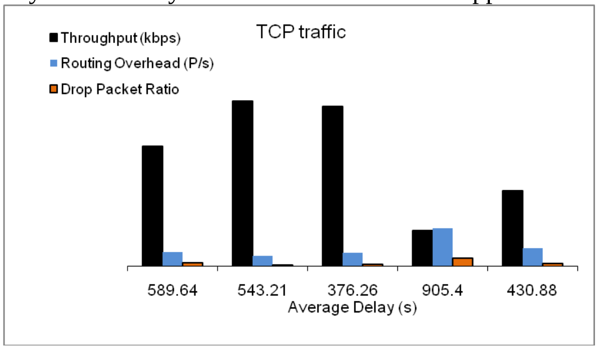

Fig.6 Qos with respect to Average Delay for tcp traffic

V. CONCLUSION

In this paper we described the AntHocNet routing algorithm. This algorithm is based on the principals of Ant colony optimization. The algorithm works in two phases' reactive path setup phase and Proactive path maintenance. In the first phase communication paths are setup and in second phase alternate paths are explored. Then we have analyzed the performance of AntHocNet with CBR and TCP traffic. Because the algorithm works in two phases and the alternate paths even are found; the route discovery frequency is less in AntHocNet. The routing overheads are increased because the hello messages are periodically forwarded. Also the effect of increase in average delay on other quality of service issues is evaluated. With increase in average delay routing overheads increase. In the future work we plan to evaluate AntHocNet performance with varying offered load and network size.

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