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A Novel Approach for Improving the Network Performance in MANET using ant Intelligence

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Abstract:- **There are various resources that is been used by wireless Ad Hoc networks. Bandwidth being a scarce resource in Wireless Ad Hoc networks, the primary challenge of such type of networks is to design an effective bandwidth management mechanism. Many approaches had introduced using certain technologies that improved the bandwidth utilization and routing to a certain extent. But, even it was possible to improve the bandwidth utilization to a certain extent, there are certain other drawbacks and it includes increase in overhead, increase in delay, less packet delivery ratio and so on. This in turn affects the overall network performance. Hence, in the proposed scheme ant intelligence is being used and along with that inter and intra flow interference is being considered. Thus by choosing the low interference path and ant intelligence technology, the network performance can be improved to a greater extent. The result of simulation displays an improved performance in terms of Packet delivery ratio, overhead and delay. Thus, the overall performance of network can be improved.**

Keywords—Bandwidth; Ant Intelligence; Interference.

I. INTRODUCTION

A wireless ad hoc network being an infrastructure less network does not rely on any pre existing infrastructure like routers in wired networks or access points in managed wireless networks. In these type of networks, each and every node can participate in routing process by forwarding data packets for other intermediate nodes. Based on the network connectivity, the decision of which node forwards data is done. This decision is done dynamically. There are various types of routing like classic routing, flooding etc and an ad hoc network in addition to classic routing also uses flooding for forwarding the data. In general we can say that in an ad hoc network all the devices have equal status. Also they can associate with any other ad hoc

network device that is within the link range. According to dynamic topology of Ad hoc networks, routing and communication between the Nodes in these networks have been challenging. To overcome this challenge, many protocols for routing in MANET have been introduced.

II. BACKGROUND

A. *Mobile agent*

A software agent is an intelligent program that acts as a user's personal assistant[6]. Software agents endowed with the property of mobility are called mobile agents. Mobile agents perform a user's task by migrating and executing on several hosts connected to the network An agent is defined as "a person whose job is to act for, or manage the affairs of, other people". In the context of computers, software agents refer to programs that perform certain tasks on behalf of the user. Imagine that you want to go on a trip to a new holiday destination. You contact your travel agent program and describe your preferences and your constraints (such as how much money you are willing to spend, when you want to travel, etc.). The travel agent program suggests where you can spend your holidays after consulting several information sources such as tourist guides and flight schedules and verifying the availability of airline tickets and hotel rooms. When you confirm your destination, the program books the flight tickets and reserves the hotel rooms for you. Thus the software agent acts as your personal assistant[6].

B. *Ant Intelligence*

Swarm intelligence (SI) is a term that needs explanation. It can be defined as the collective behaviour of decentralized, self-organized systems

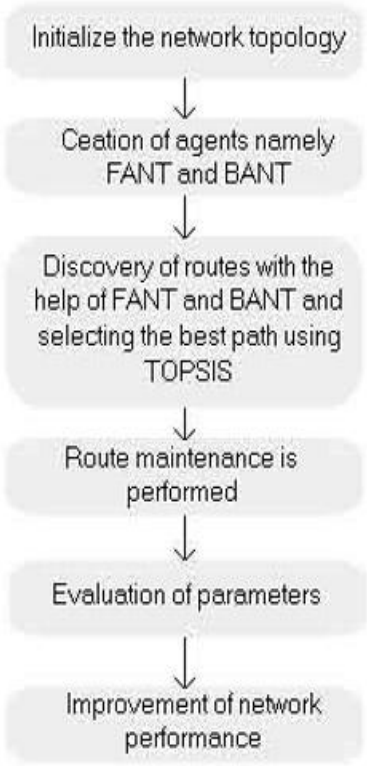

Figure.1 Overview of the proposed system

These systems can either be natural or artificial. The collective behaviour can be referred to as a social processes or events and it should not reflect
any existing structure. But, they can emerge in a spontaneous way. This concept is used mainly in

the work of artificial intelligence. The Swarm Intelligence is a system that mainly consists of simple agents or ants. These agents or ants have the capability to interact locally with one another. Also they can interact with their environment.

III. EXISTING SYSTEM

Most of the systems are trying to improve the system or network performance to a greater extent and in case of MANETs; there are various resources that are scarce due to which implementation of an efficient and effective system that improves the performance is quiet difficult. They possess a major drawback of increased routing overhead, more end to end delay etc and this degrades the overall network performance.

IV. PROPOSED SYSTEM

In this paper, a novel approach for improving the network performance has been introduced. There are various reasons due to which a system or a network performs poor. It might be due to poor bandwidth utilization, more delay, low throughput, low packet delivery ratio and so on. The proposed system uses the concept of ant intelligence and this is being inspired by the ant's foraging behaviour[5]. When we talk about the foraging behaviour, the ants are normally attracted towards higher concentration of pheromones that helps them to choose the shortest path. The same concept is being used in this proposed scheme. Also, an approach called TOPSIS [7] using agents has been used for choosing the best path among various existing paths based on certain criteria's. Using these concepts and choosing low interference paths helps in improving the network performance to a greater extent. TOPSIS approach is a quiet simple approach and it is required to understand the basic concept behind this. An idea about this approach is being given below.

a) TOPSIS Method

TOPSIS stand for "The Technique for Order of Preference by Similarity to Ideal Solution and it is a multi-criteria decision analysis method[7]. The concept behind TOPSIS approach is quiet simple[7]. That is, the chosen alternative must be as close as to the ideal solution or in other words it should be as far as possible from negative-ideal solution. There are certain advantages of using this particular concept which has been explained below.

b) Classification of Incoming Packets

A packet can be either be a control packet or it can be a data packet. Control packet means it can be a route request, route reply, acknowledgement, route error etc and the data packet contains the actual data that has to be sent from source to destination. So, classifying the control and data packets is the initial requirement and there are different ways to differentiate them. Both the data packet and control packet has a specific structure. For a data packet, the structure depends on the type of packet and also on the protocol and also a packet has a header and a payload.

In the proposed system, whenever a packet arrives, it has to be identified as a control or a data packet[7]. If the packet seems to be a control packet, then further required processing has to be performed. For example, if the packet is route request, the appropriate route has to be determined and if it is route error, then a route error message has to be initiated and so on. And if the packet arrived is a data packet, then it has to be routed to the specified destination. To perform this, an assumption has been done in this work.

c) Routing

Routing is the major factor to be discussed when we talk about managing networks. It is always required to find a best path or route to sent data packets between the nodes and routing is the procedure of choosing best paths in a system[2]. Routing is complete when route discovery and route maintenance is performed.

In the proposed system, two types of agents [7]or ants are used for the routing purpose. These ants are namely Forward ants (FANT) and Backward ants (BANT) and both of them has its own specific function. The function of FANT is that it explore the paths of the network and this is basically in search of routes from a source to a destination. On the other hand what the BANT does is that it establishes the path information that is being acquired by FANT. Also, these has another function that it create a bias at each node and this is for its neighbours by leaving a pheromone amount from its source[5].

d) Data/Routing table

Each node in the network has a routing table and in terms of computer networking, a routing table, or a routing information base (RIB) is actually a table, more specifically a data table. This table basically lists the routes to destinations and also in certain cases, the distances associated with the routes. The data table contains the information about the topology of the network that is immediately around it as well. Hence, we can say that the construction of the data table is the primary of every routing protocols.

In the proposed system, the size of the data table is actually the degree of the node times all the nodes that is in the network. In other words, if the total number of nodes in the network is `N' and the degree of a particular node $u_i$ is $d_i$ then the size of the routing table is given by N$d_i$. Now about the rows and columns of the table, the rows of the routing table represent the neighbours of the node `u' and the columns represent the complete nodes in the network. Also each pair (row, column) in this routing table has mainly two values:

1. A binary value indicating if the node Has been visited and
2. The pheromone concentration.

e) Route Maintenance

It is required to detect and monitor the links to neighbours and this is normally done using the hello messages. Periodic broadcasting of hello messages are done by each and every node such that all its neighbours those that are within its transmission range will receive this. Normally, the hello messages are transmitted at an interval called hello interval seconds. As the hello messages are broadcasted periodically, and if a particular node fails to receive several such messages from a neighbour, a link breakage can be detected. Once a link breakage is detected, its routing table can be updated by deleting the entries in the routing table for that neighbour. This is how routing table is managed in the proposed system.

f) Route Discovery

Route discovery is the initial process in Routing. Route discovery can be done in different ways. In this paper, the route discovery procedure is done as follows[8]. Let S denote the source node and D represents the destination. Suppose that the source node S wishes to communicate with the destination node D. But, S does not have any route information to D. In this case, source node S sends out an agent or an ant named FANT to all its neighbours in search of the destination node. Now, when the forward ant, FANT from S travelling to D, arrives at a particular node say, u, the FANT determines its path or next hop neighbour. This discovery of path or next hop neighbour is done by looking at the node's routing table.

In the proposed system, the rows of the data table represent the neighbours of the node u and the columns represent the complete nodes included in the network. Hence, it considers node v's neighbours by looking at the rows against the column D in the data table. Now, by considering the column D in routing table, the FANT will choose the best path (based on bandwidth, delay, cost) from a neighbouring node to D rather than the best link between itself and its neighbour. The forward ant (FANT) consider the pheromone concentration and this is done only when all the neighbours in column D has been visited. This is basically done for a particular purpose. It is required to ensure that all possible paths to destination are explored in order to find the best path. Once the FANT has identified that it has not visited a particular node before, then the node with highest pheromone concentration is chosen as the next hop. The main advantage of doing this is to avoid the ants or agents travelling in cycles. In order to avoid the ants travelling in cycles, what the forward ant does is that it always keeps a list of all the nodes visited on its journey towards the destination node. Also, the ant keeps in memory the total time it has travelled and the total time travelled being denoted by T.

g) Updating Pheromone Concentration

Whenever a next hop u_j is selected from a particular node u_i then the forward ant will move towards uj and then it will update the pheromone entry for (u_i, S) in u_j's data table using the following equation.

$$^{\delta}(u_i, u_s) = {}^{\delta}(u_i, u_s) + \frac{\varepsilon}{(T(u_s, u_i) + \omega(u_i, u_j))} \qquad (1)$$

Here δ is the user defined run time parameter, represents the value of pheromone in each edge and $\omega(u_i, u_j)$ denotes

the time period. Time period means the time for which the links are in connection. Now we have to calculate the values of pheromones of other nodes. That is, for all those other nodes that are in the source column, the value of pheromones has to be decreased. This is using the equation as below:

$$\delta(u_{l,}u_s) = (1-\delta)\,\delta(u_{i,}u_s)\,, \forall l \neq i \qquad (2)$$

δ is the evaporation rate of the pheromone value and it can be determined by the user. Now, the total time of the path travelled should also be recorded and in the proposed system it is done using $\mathrm{T}(u_{s,}u_i) + \omega(u_{i,}u_j)$.

Now, let us consider the reverse process. Once the FANT reaches the particular destination, a BANT will be created. The source of BANT is the destination of FANT and BANT moves towards destination by using the visited nodes list that is being acquired from forward ant. Also it updates the concentration of pheromone value for the destination. The main reason for this is that, it should increase the concentration of pheromone which is closest to destination node. And the concentration of pheromones for all other nodes has to be decreased. That is, to update the entry $(u_{b,}u_D)$
For an ant at node u_k.

$$\delta(u_{b,}u_D) = \delta(u_{b,}u_D) + \frac{\epsilon}{T'} \qquad (3)$$

Where T' is $\mathrm{T}(u_{s,}u_d) - \mathrm{T}(u_{s,}u_k)$

There is a particular advantage of doing this update. That is, due to this update it becomes more easy to find the best path available.

h) Interference

The major problem as we have seen is in choosing an optimal path for routing. Most of the times certain paths will have more interference and certain other paths have lesser interference. Hence, choosing low interference path too can improve the network performance of MANET to a greater extent. In the proposed system this is also considered which helps in getting a better performance.

The total interference is calculated using the equation:

$$ITT_{i,c} = IFLD_{k,i,c} \times \alpha \qquad (4)$$

Where α is the cost factor and is given by

$$\alpha = \frac{2Q_{next}\,L}{B_i}, \qquad (5)$$

where Q_{next} is defined as the nuber of packets that is waiting in the queue, L is the size of a packet and B_i is the bandwidth available for a particular link.

The $IFLD_{k,i,c}$ is the interference link delay and is given by :

$$IFLD_{k,i,c} = L_{Qi} \times \max[I_{(k)}] \qquad (6)$$

Where $I_{(k)}$ is the set of queue sizes of node k's interfering nodes.

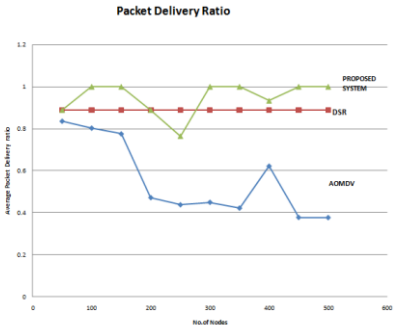

Figure.2 Comparison of average Packet Delivery Ratio

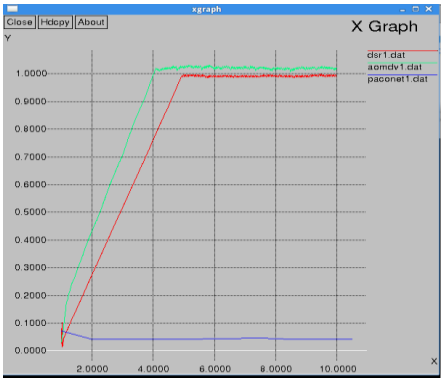

Figure.3 Comparison of end to end delay

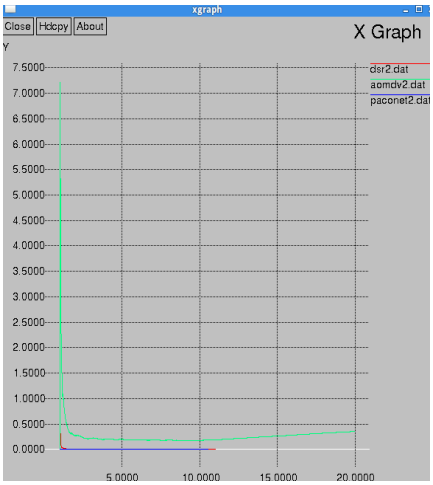

Figure.4 Comparison of Routing overhead.

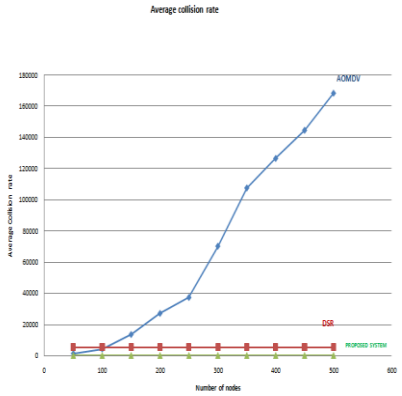

Figure.5 Comparison of average collision rate

V. RESULTS AND ANALYSIS

Different scenarios were created at NS-2 and run. The NS-2 version used is NS-2.35-allinone. It produces two file as output - Nam and Trace file. AWK programming language is used for analysis the trace file and use the trace file to compute end-to-end delay, Routing overhead and average packet delivery ratio.

a. Routing Overhead

"Figure.2," shows the comparison of average packet delivery ratio of the three protocols and it is clear that the proposed system performs better when compared to existing systems, namely DSR and AOMDV. Routing simply means finding a path or route from a source node to destination node so that data packets can be sent efficiently. But determining the paths may take time and as some paths may be shorter and some longer. Paths may be many but choosing the best from many paths takes more time that leads to routing overhead. The lesser the routing overhead, the better the performance of the network.

b. End to end packet delay

" *Figure.3*," shows the end to end delay comparison. It shows that among the three protocols, Proposed system (PANET), DSR and AOMDV the proposed system has less delay. End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination. The lesser the end to end packet delay the better the performance of the protocol and also improve the network performance.

c. Packet Delivery Ratio

"*Figure.4*," is the comparison graph of routing overhead and the result shows that the proposed system and the existing protocol DSR posses the same routing overhead. But, when compared to AOMDV, it has lesser routing overhead. Packets are transmitted across a network from source to destination. Packet Delivery Ratio can be referred to as the maximum number of packets that can be received by the destination from the total number of packets sent by the source node.

d. Collision Rate

"Figure.5," is the comparison graph for average collision rate. The result shows that AOMDV posses the highest collision rate when compared to DSR and the proposed system. Also, DSR has more collision rate than the proposed system. Thus, we can conclude that the proposed system is better in terms of collision rate than the other two existing protocols.

VI. CONCLUSION AND FUTURE WORK

In the proposed system, a novel approach for improving the network performance is being introduced. Here the introduction of ant intelligence and choosing a best path with low interference for routing plays a vital role. This helps to improve the overall network performance to a greater extent. This new protocol is compared with two other existing protocols namely, AOMDV and DSR in terms of routing overhead, end to end dealy and average packet delivery ratio, and was able to show that this performs better than the existing ones. To increase the merits of my work, factors like link quality estimation, energy consumption, and load balancing can be considered.

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