A Real Trust Behaviour Based ACO Routing Algorithm for MANET

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Abstract- The Ant Colony Optimization technique is used in this research to locate routes in a MANET, which is a novel approach. Pheromone values are updated in this protocol using a real-life trust behavior technique. In an ACO-based protocol, the start and updating of pheromone values are critical to the system's success. We used various methods to initialize the pheromone values and then changed them based on real-world trust behavior. Simulation tests over NS2 for 20-50 nodes in a 800x800 region are used to compare the AODV protocol and our proposed protocol.We show that the suggested protocol can exceed AODV in average delay and delivery ratio parameters. In terms of jitter and packet drop also, the proposed approach performs better. Because many disjoint routing paths give robustness to mobility, our investigation reveals that the proposed protocol outperforms existing pertinent techniques.

***Keywords*:** MANET, Trust Based algorithm, ACO, Routing Algorithm, AODV.

1. INTRODUCTION

Wireless networking gives electronic accessibility of services and information regardless geographic position of the user. Wireless network are basically of two types. This property of self-configuration and self-organization makes these networks unique and of higher applicability. Mobile Ad-hoc networks are self-configuring network [1]. They are infrastructure less networks and communication is done over wireless medium. These networks are self configuring in a sense that for connection establishment, routing or for link maintenance, no designated devices are used. Mobile node using radios communicate through each other and are responsible for finding and maintaining optimal route for transmission of data packets. Self-configuring nature of these networks, make them highly desirable in some fields like disaster recovery, police and military networks, mining operations, safety and rescue operations and in providing efficient, secure and comfort driving (VANET). Due to dynamic network connections routing is a tough task in MANET. Wireless link and frequently changing topology makes the route discovery and maintenance a tough task. A reliable path found at any instance of time can become highly unreliable after sometimes. Discovery of stable path is important in these networks due to energy limitation of mobile nodes [2].The size of MANET is required to be of larger size than that of the radio range of the wireless antennas. The size of the MANETs makes it necessary to do routing in a multi-hop fashion to provide communication ability to two nodes placed far apart in the network[3].MANETs contrast infrastructure network on the basis of multi-hop routing also. In infrastructure networks only one hop communication between mobile nodes and base stations is allowed. But in case of MANET all nodes can work as router and can establish multi-hop routes. An infrastructure network and MANET is depicted in Figure 1 and in Figure 2 respectively.

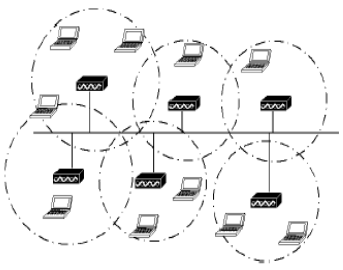

Figure 1 Network with fixed infrastructure

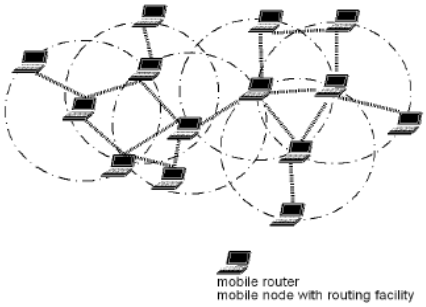

Figure 2. Mobile Ad hoc Network

- Proactive Protocols: These protocols use tables for routing information. Each node keeps track of all routes to known destinations in a routing table.[6] Routing data is available at all times, but storage costs are considerable.
- Reactive Protocols: These are on-demand protocol, i.e. the route is discovered when it is demanded by any node. Storage overhead is low as no unnecessary route information stored.
- Hybrid Protocols: They combine the positive factors of both previously defined protocols. By mixing the features of two protocols better results are obtained.

Figure 3 depicts the routing protocols classification.

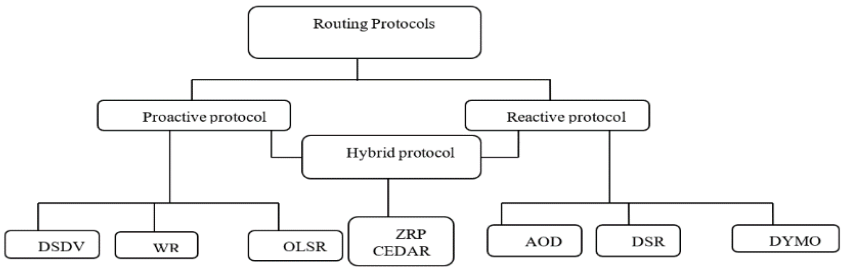

Figure 3. classification of MANET routing protocols

Before we precede toward our proposed algorithm it is necessary to understand ACO based routing and its suitability for routing in MANET.

The Ant Colony Optimization Approach: ACO represents a colony of the artificial ants which find global solutions to the challenging optimization problems through cooperation [8]. Artificial ants are the mobile agents that are somewhere different from the real ants. These mobile agents inherit the some traits from their natural counterpart but with that they have some additional properties that make them more relevant to be used with an engineering approach to solve some difficult problems and to provide efficient solution to them. Below are some traits that compare natural ants with the artificial one.

In [12], a large scale network is considered for routing. This protocol works over the concept of "logical routers" and "logical link". Logical routers are formed by the grouping of nodes which are geographically close.[10] So we can say that logical routers are collection of nodes and logical links are the paths between them. This protocol is also inspired by social behavior of insects. This paper represents a novel hybrid ACO based protocol called Ant Hoc Net[13]. MANET are dynamic in nature due to which routing is very tough in such network. In the demand based route discovery, forward mobile agents are used that collect the network information and on reaching the destination converted into backward ants to update the route information at each node. This algorithm provides multiple path setup facility. [11]The path maintenance phase exhibits the proactive behavior because along with the data packets some proactive ants are also sent that maintain the existing path and also try to find new ones. In[14], Lianggui Liu et al. recognized the problem of having single route selection which lead to load on shortest path. The paper represents a new routing theory named as AMQR. This protocol combines link disjoint multi-path routing and swarm intelligence approach. This protocol is very adaptive in nature and has better QoS support. In[15], author gave a unique approach of routing in MANET in which route discovery (reactive) and route maintenance (proactive) is done in hybrid manner. Ant like mobile agents is used in this ACO routing technique. Results show that this algorithm works efficiently than AODV in different scenario. In[16]an ACO based algorithm called ARAMA is proposed which performs resource management in MANET routing. Simulation of this work is done on GlomoSim for the comparison between HOPNET with AODV.

To achieve the efficient routing an ACO based scheme for multipath routing is proposed which is based on real life trust behavior. The proposed approach consider the value of pheromones as a key factor and gave a unique protocol.Pheromone disposed on the path defines the goodness and utility factor of that path. In this way initializing value of that pheromone and how these values are getting updated plays very important role in the performance of the algorithm. In our proposed algorithm we have especially worked over these two factors.

2. Proposed Approach

The proposed protocol exploits ACO for the construction of optimum routes based on AODV approach. The main objective of this research is to propose an ACO based protocol in which pheromone update process is inspired by a practical trust behaviour. Pheromone disposed on the path defines the goodness and utility factor of that path. In this way initializing value of that pheromone and how these values are getting updated plays an important role in the algorithm performance. In our proposed algorithm we have especially considered over these two factors. In ACO based routing algorithm pheromone values tells that how beneficial it would be to take that path to reach a particular destination, so in a way we can say that pheromone represents the trust toward that path. We merge this concept with real world trust assessment. Finally the analysis of performance is done on the basis of different matrices. Simulation output shows that our algorithm outperformed AODV under different parameter.

In ACO pheromone values are required to be initialized at the starting part of procedure. Conventionally for ACO, all ant tracks are initialized with zero (0) since it is assumed that initially pheromones are not available on the tracks. But in our proposed algorithm, we initialize the pheromone value in somewhat different way. We initialize it with one (1). It is because of the fact that the pheromone intensity also represents the connection in between two residing routers. A path having zero (0) intensity represents that there is no connection in between two routers. Here intensity of pheromone represents the values of pheromone.

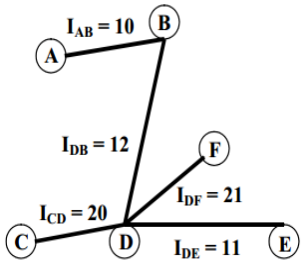

Figure 4.A network topology with a stable pheromone intensity

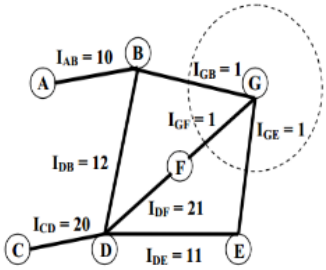

Figure 5. Changed topology in case ofaddition of a new router G.

We modified this approach and initialize the pheromone value by 1 which enhances the performance of algorithm. This modification is done in order to show that there is a path between B & G, F & G and E & G and Figure 5 clearly shows these modifications. One more benefit of using 1 as an initializing value is that if the source found that destination is in its routing table and has intensity value 1 i.e. if the source has direct link with the destination, then source would avoid sending any kind of ant packets in spite it would send a data packet directly.

Before discussing the core idea of pheromone updation behind our proposed approach, we will first take a real world example of trustworthiness evaluation as well as its changing behavior with changing circumstances and then explain our approach which will make it easy to understand the real benefits of applying this idea to this ACO based multipath routing algorithm for MANETs.

Let us consider a scenario of trust building process between initially two unknown people like Person A and Person B. Here, an assumption is taken that these two people have taken help from each other at 10 occasions and given a feedback in a binary manner, i.e. either they were happy with response or not.

Case1: If Person A continuously betrayed the trust of Person B for first three to four times, then there is a drastic decrease in trust level of Person B towards person A is noticed.

By considering this case we proposed a change in pheromones evaporation. Pheromones evaporation can be done exponentially because after each unsuccessful attempt of message/packet delivery, the trustworthiness of the route will degrade very drastically.

$$I_{AB}(new) = e^{(q-1)} I_{AB}(old)$$

Where; I_{AB} (new) = Updated pheromone value
I_{AB} (old) = Old pheromone value
$q \in (0, 1]$

Case2: If Person A continuously kept the trust of Person B for first three to four times, then there is a multiplicative increase in trust level of Person B towards person A will be noticed.

The same approach is applied in our practical trust base approach. In our proposed algorithm, pheromone value are updated in a quadratic manner because after each successful attempt of delivering whatever message or data we wants to deliver, the trustworthiness of the route increases multiplicatively.

$$I_{AB}(new) = I_{AB}(old) + (I_{AB}(old) * (q-1))^2$$

Where; I_{AB} (new) = Updated pheromone value
I_{AB} (old) = Old pheromone value
$q \in (0, 1]$

METHODOLOGY

This section defines all the basic function of the proposed routing algorithm.

Initialization: In our algorithm the pheromone values are initialized as one (1) in case there is any direct link in between two nodes. The concept of initialization is briefly explained before.

Route establishment: Route formation is a compulsory task in each routing technique. It is the basic job that router is allocated to perform. This job is performed as following:
When a new node enters in the web or at commencing of web, at early this router first finds its bordering or neighbour router and initializes the intensity of these paths as one (1). In addition, primarily it considers that across every single path, it is probable to grasp each router of the network. A kind of vector table is maintained such as distance vector routing in which intensity of their paths is stored. The table is coordinated in the standard form of "from A to B through C". But in spite of distance, it holds the intensity of given link. With bypassing of period, most excellent outgoing link for particular hosts will get stable in intensity table.
Route discovery: The proposed routing method doesn't dispatch RREQ packet as AODV or any other action as DSR. Yet it maintains its reactive nature. It sends ant packets for route discovery that calculate probability of each path. Before dispatching any packet to particular destination, it searches and selects the path on the basis of probabilistic selection explained below. Paths that are used in past by the most of the packets gets higher priority in selection. The given path invention is the adaptive method established on Ant Dominion Optimization and it becomes stable in the end by discovering nature.

These BAnts traverse backward and they update respective routing tables at each intermediate node and on reaching the destination (generator of the FAnts) they update its routing table and released. For each adaptive algorithm, probability calculation is a most vital issue but in given algorithm it plays an important responsibility. Successful accomplishment of given algorithm is affected by proper calculation of path probability. As dispatching the packet from one router to one more router, the path is selected with this probability. Probability of a path in this algorithm is computed on the pheromone intensity. Trail probability is described as,

$$P_i = \frac{I_{ij}}{I_t}$$

where, P_i = probability of the path connected with router. I_{ij}=intensity of path connected with router and node j.
I_t=summation of intensity of entire path connected with router.

- **Route Maintenance:** Proposed method maintains its path in an adaptive way. If a router gets down, it would be impossible to deliver any packets through the path containing that router. So due to pheromone evaporation the selection probability of thatpath would be decreased and other paths would begin to get priority over the path containing the broken link. If the down router gets back to network then that link would be established again.
- **Route selection:** Selection of routes is done on the basis of the probability calculated. Selection of each path is directly proportional to probability of that path. Pheromone deposition and evaporation process is defined earlier in this section.

3. SIMULATION AND RESULT ANALYSIS

All the simulation work has been done over NS 2. It is an event-driven tool for simulation. We present the simulation results as well as compare the proposed protocol with exiting protocol. This simulation and result demonstrate the correctness of propose scheme. Performance evaluation of the proposed protocol is done through following matrices:

- **Throughput:** This parameter defines the overall performance of the algorithm in terms of packet delivery ratio.
  In Figure 6 Xgraph shows a comparison between AODV and proposed algorithm. Where x-axis presents Simulation time (Sec) and y-axis represents packet delivery ratio.
- **End to end delay:** In Figure 7 on x-axis simulation time and on y-axis End to End Delay for each node (ms) is presented.
- **Jitter:** Jitter represents the variation in delay of received packets, i.e., when data packet flow from one node to another node some packet take longer time in transmission that cause variation in latency on data flow.
  Figure 8 represents graphical representation of jitter in AODV versus that in proposed algorithm. In graph x axis shows packets and y axis shows jitter value.

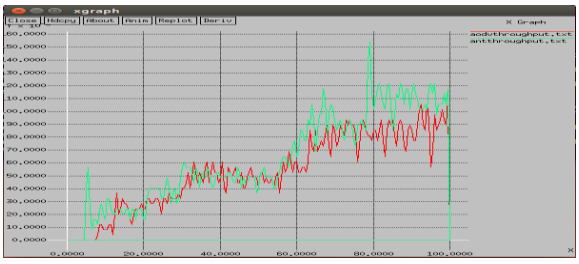

Figure 6. Xgraph for Throughput

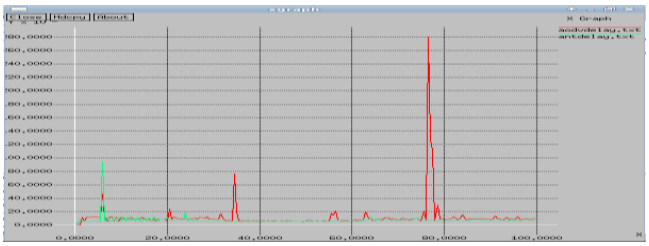

Figure 7.XGraph plotted for End to End Delay

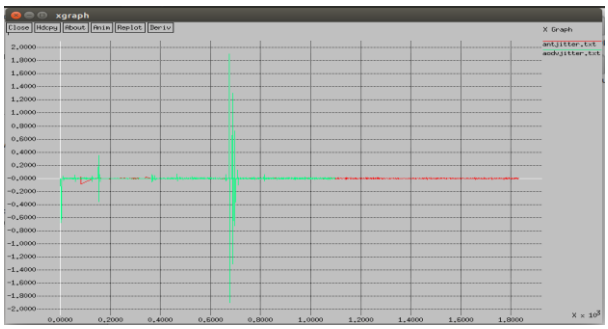

Figure 8.XGraph plotted for jitter

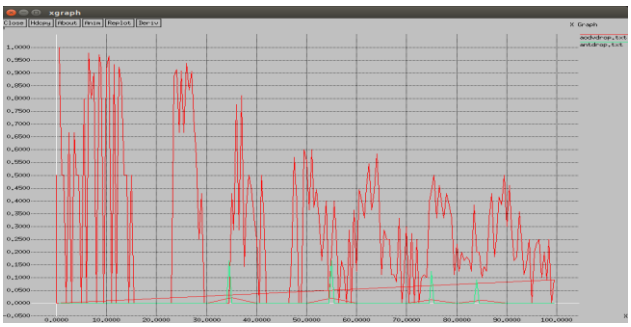

Figure 9. XGraph plotted for packet drop

Packet drop: In Figure 9 XGraph for packet drop (AODV v/s proposed algorithm) is drawn in which simulation time is taken on X-axis and drop rate is taken on Y-axis

CONCLUSION

We have proposed a multipath ANT-based routing protocol and a new ant-based algorithm. The hybrid algorithm is what it's called. The hybrid algorithm combines proactive route probing and exploration with reactive route setup. The routing method is based on swarm intelligence, specifically a meta-heuristic based on ant colonies. With little routing overhead, the protocol can identify numerous routing paths. Our suggested approach uses practical trust theory-based pheromone updating and also introduces a new method of initializing pheromone values, which improves the proto-overall col's performance. Simulation studies are also used to validate the protocol's usefulness. By considering delivery ratio and average delay, we show that the suggested protocol can outperform AODV in tough cases during the simulation process. The proposed approach also outperforms the competition in terms of delay jitter. We plan to expand and emphasize proactive ants' inquisitive behavior in future research. More information regarding probable path enhancements will be offered in the nodes as a result of enhancing the idea of pheromone diffusion, and this knowledge can guide proactive ants. As a result, you'll get better outcomes with less effort. Additionally, this technique can be improved by including safeguards against assaults such as black holes. In addition, an attempt will be made to develop a virtual circuit-based method. This could lead to greater path control, resulting in more dependable data transmission. Because many disjoint routing channels give robustness to mobility, our investigation reveals that the suggested ant-based approach outperforms existing pertinent techniques.

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Biographies

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