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Ant Colony Optimization Techniques in MANET for Efficient Routing: A Survey

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Abstract
All networks tend to become a lot of and a lot of difficult. They'll be wired, with several routers, or wireless, with several mobile nodes, the matter remains the same: so as to induce the best from the network, there's a requirement to search out the shortest path. The a lot of difficult the network is, the harder it's to manage the routes and indicate which one is that the best. The ants, in their necessity to search out food and brings it back to the nest, manage not only to explore a huge space, however additionally to point to their peers the location of the food whereas transportation it back to the nest. Thus, they grasp wherever their nest is, and additionally their destination, while not having a worldwide read of the bottom. Most of the time, they will notice the shortest path and adapt to ground changes, therefore proving their nice efficiency toward this tough task. In this work we proposed load balancing and reliability enhancement using Ant based approach in MANET. The Ant behaviour of follow search routing is on the basis of pheromones. The pheromones are injected by ant in a route and follow that route were the pheromones are more injected means that route is the suitable route for reaching to destination. In this paper we presents the different techniques of Ant Colony Optimization (ACO) that are improves the routing mechanism.
Key Words—MANET, Ant, Pheromones, Survey, ACO

I. INTRODUCTION

A Mobile Ad-hoc network also called MANET [1] consists of a set of nodes that communicate with each other using a wireless medium over single or multiple hops and do not need any existing infrastructure such as access points or base stations. Therefore, mobile ad-hoc networks are suitable for temporary communication. The biggest challenge in this kind of networks is to find a path between the communication end points. The routing scheme in a MANET [1] can be classified into two major categories- Proactive and Reactive. The proactive or table driven routing protocols (DSDV) maintain routes between all node pairs all the time. It uses periodic broadcast advertisements to keep routing table up-to-date. This approach suffers from problems like increased overhead, reduced scalability and lack of flexibility to respond to dynamic changes. The reactive or on demand (DSR, AODV) approach is event driven and the routing information is exchanged only when the demand arises. The route discovery is initiated by the source. Hybrid approaches combines the features of both the approaches.

The ant colony optimization rule (ACO) [2, 3] could be a probabilistic technique for finding computational issues which may be reduced to finding smart methods through graphs. This algorithm could be a member of ant colony algorithms family, in swarm intelligence strategies, the first rule was reaching to seek for a best path during a graph; supported the behaviour of ants seeking a path between their colony and a supply of food. the first plan has since varied to solve a wider category of Numerical issues, and as a result, many issues have emerged, drawing on numerous aspects of the behaviour of ants. The figure 1 represents the ant routing behaviour on the basis maximum pheromones. 1 ant search route, 2 ants follow possible routes, 3 ants follow routes on the basis of pheromones.

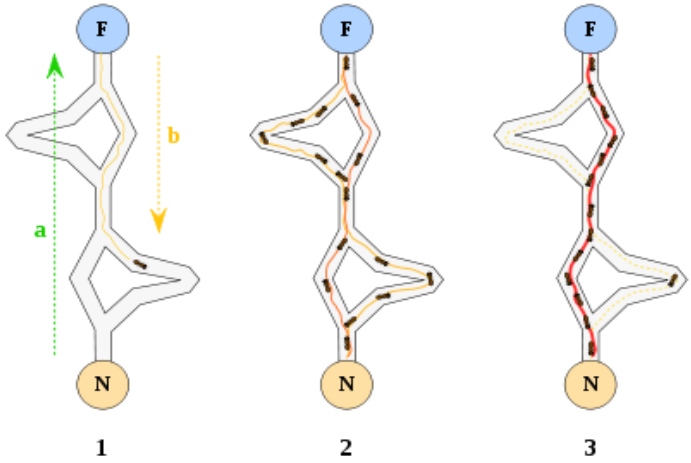

Fig. 1 Ant Behaviour for Search Path

Ant Colony Optimization (ACO) is a subset of Swarm Intelligence. The basic idea of the ant colony optimization is taken from the food searching behavior of real ants [4]. When ants are on the way to search for food, they start from their nest and walk toward the

food. When an ant reaches an intersection, it has to decide which branch to take next. While walking, ants deposit a pheromone, which ants are able to smell, which marks the route taken. The concentration of pheromone on a certain path is an indication of its usage. With time, the concentration of pheromone decreases due to diffusion effects. This property is important because it is integrating dynamic into the path searching process.

The paper is organized as follows: Section II of this paper basically gives the brief information about ACO in MANET in Section II and Section III describes the key concept of AODV protocol some previous works related to this research work are disused in Section IV. Concluding remarks are given in Section VI.

II. ACO IN MANET

This behavior of the ants can be used to find the shortest path in networks. Especially, the dynamic component of this method allows a high adaptation to changes in mobile ad-hoc network topology, since in these networks the existence of links are not guaranteed and link changes occur very often. Also ACO mainly suits for ad hoc networks due to link quality, local work and support for multipath [4, 5]. Now there are various reasons by considering important properties of mobile ad hoc networks.

Dynamic topology is responsible for the bad performance of several routing algorithms in mobile multi-hop ad hoc networks. The ant Colony optimization meta-heuristic is based on agent systems and works with individual ants. This allows a high adaptation to the current topology of the network.

Local work - In contrast to other routing approaches, ant Colony optimization meta-heuristic is based only on local information i.e., no routing tables or other information blocks have to be transmitted to neighbors or to all nodes of the network.

Link quality is possible to integrate the connection/link quality into the computation of the pheromone concentration, especially into the evaporation process. This will improve the decision process with respect to the link quality. It is here important to notice, that the approach has to be modified so that nodes can also manipulate the pheromone concentration independent of the ants, i.e. data packets, for this a node has to monitor the link quality.

Support for multi-path - Each node has a routing table with entries for all its neighbors, which contains also the pheromone concentration. The decision rule, to select the next node, is based on the pheromone concentration on the current node, which is provided for each possible link. Thus, the approach supports multi-path routing.

III. AODV ROUTING PROCEDURE

Ad hoc On demand Distance Vector (AODV) routing protocol are comes in the category of reactive routing protocols that are not maintaining the routing tables, only doing on demand routing means AODV [6] discovers routes on an as needed basis via a similar route discovery process. However, AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. In contrast to DSR, RERR packets in AODV are intended to inform all sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

IV. RESEARCH HAS DONE IN THIS FIELD

The **Bibhash Roy et. al.** [7] proposed Ant Colony based Routing for Mobile Ad-Hoc Networks towards Improved Quality of Services. A brand new Quos algorithmic rule for mobile ad hoc network has been planned. The projected algorithmic rule combines the thought of ant Colony optimisation (ACO) with Optimized Link State Routing (OLSR) protocol to spot multiple stable methods between supply and destination nodes. The challenges reside in ad hoc networks is to seek out a path between the communication finish points satisfying user's QoS demand which require to be maintain consistency. The rule consists of each reactive and proactive element. In a very reactive path setup section, a choice of multiple methods selection will be accustomed build the link between the source and destination during an information session.

S. Soundararajan et al [8] describes about Ant Based Multi-path Routing for Load Balancing and Congestion Control in MANETs. A lot of message overheads are caused attributable to enlarged flooding. Packets are dropped by midway nodes because of frequent link failures. What is more the general turnout and therefore the packet delivery quantitative relation is reduced in

high quality situations. so as to beat the problems an efficient multi path routing protocol ABMRLBCC (Ant based mostly Multi-path Routing for Load levelling and Congestion Control) supported ant Colony improvement is projected. A reactive path is about up by the forward ant that provides the routing data of a node. The most effective path for each ant is selected the amount upon the quantity of hops and period of time. The backward path choice scheme determines the common node and therefore the path that has been omitted. The omitted reverse path variety totally different common node variety is used for determinative the most effective forward path. Their results show that the planned protocol performs higher, in comparison with existing protocol. Once the network size and therefore the speed of the mobile are increased, it shows higher performance in terms of packet delivery quantitative relation with reduced delay and overhead.

Sharvani G S et al. [9] assist in reducing management overhead because of their inherent ascendable feature. The similarity between ant and nodes, colony and Wireless network improves to use ACO based mostly routing in MANETs. The white ant Algorithms contains many tuneable parameters and strategies to alter the choice of best routes for various network conditions. The MTA developed by adopting economical secretion evaporation technique can address to load equalization issues. By together with QoS, economical route maintenance, native repair strategy by prediction of node failures, the MTA is predicted to boost the performance of the network.

The algorithm is based on balancing the load among the routes by calculating threshed value of each routing table & ant's helps to effectively balance the loads as it find a pair of under loaded and over loaded nests. This paper defines implementation of ad-hoc n/w and comparison of its performance with AODV routing protocol based on ant algorithm is done in terms of packet delivery ratio, end to end delay and load. Performance of our algorithm in comparison with AODV is much better [10]. Mobile ad-hoc network is a network having inherent features i.e. dynamic topology, lower band width, multi-hop routing, distributed control and lack of load balancing capability. So there is a need to speed up this type of network by using various techniques. One of the most active areas of research in MANET is swarm based routing based on ant optimization techniques.

M. Ahmed et al. [11] propose two ways to enhance the Ad-Hoc On-Demand Distance-Vector (AODV) protocol. The main goal within the design of the protocol was to reduce the routing overhead, buffer overflow, end-to-end delay and increases the performance. A multi-path routing protocol is projected which relies on AODV and ant Colony optimization (ACO). This protocol is refereed to Multi-Route AODV ant routing (MRAA). Also we have a tendency to propose a load balancing technique that uses all discovered ways at the same time for transmittal knowledge. During this technique, information packets are balanced over discovered ways and energy consumption is distributed across many nodes through network.

ACO has been formalized into a meta heuristic for combinatorial optimization problems by Dorigo et al. [12, 13]. ACO takes inspiration from the foraging behavior of ant species which deposit pheromone on ground in order to mark some favorable paths that should be followed by other members of the colony. ACO exploits a similar mechanism for solving optimization problems. An individual ant is a simple insect with limited memory and capable of performing simple actions. Though a single ant has no global knowledge about the task it is performing and its actions are based on local decisions and are usually unpredictable, an ant colony expresses a complex collective behavior providing intelligent solutions to problems such as carrying large items, forming bridges and finding shortest routes from nest to a food source. This intelligent behavior naturally emerges as a consequence of self-organization and indirect communication among ants which can be termed as emergent behavior or swarm intelligence.

P. Deepalakshmi et al. [14] have proposed an ant based QoS routing protocol for MANET to support multi-media communications. From the given source to destination multiple paths have been found with varying path preference probability. The multimedia data is sent over the path with higher path preference probability which can provide lesser delay, higher bandwidth and shorter path in terms of number of hops.

B. R. Sujatha et al. [15] have proposed a PBANT algorithm which optimizes the route discovery process by considering the position of the nodes. The position details of the nodes (position of the source node, its neighbors and the position of the destination) can be obtained by positioning instruments such as GPS receiver. PBANT is basically ARA where position details of the nodes are known a priori. In this study, the performance of PBANT has been evaluated in terms of delivery rate, delay and control traffic, for different values of the algorithm parameters.

Shahab Kamali et al. [16] have proposed POSANT, a new ant colony based routing algorithm that uses the information about the position of nodes to increase the efficiency of ant routing. In contrast to other position based routing algorithms, POSANT does not fail when the network contains nodes with different transmission ranges. Unlike the previously defined position based routing algorithms which are single path, POSANT is a multi-path routing algorithm. While in some cases regular position based routing algorithms find a route which is much longer than the shortest path, POSANT converges to routes which are close in length to the shortest path.

S. Kannan et al. [17] have proposed a multi agent ant based routing algorithm for MANET, an ACO frame work is described. It is a hybrid algorithm,

combines the concepts of multi agents and ant algorithm. In routing algorithm this combines both proactive and reactive components together and forms a hybrid routing algorithm. This technique increases node connectivity and decreases average end to end delay and increase packet delivery ratio.

Sarala.P et al. [18] have proposed a paper to support the reliability as a QoS metric through multipath routing.. They presented work on Multipath Dynamic Source Routing (MPDSR), which is based on Dynamic Source Routing (DSR) protocol. MPDSR seeks to compute a set of unicast routes that can satisfy a minimum end-to-end reliability requirement. It then maintains this requirement throughout the lifetime of transmission.

Srinivas Sethi et al. [19] have introduced a novel metaheuristic on-demand routing protocol Ant-E, using the Blocking Expanding Ring Search (Blocking-ERS) to control the overhead and local retransmission to improve the reliability in terms of packet delivery ratio (PDR). This method enhances the efficiency of MANET routing protocol. Ant-E is inspired by the ant-colony optimization (ACO) used to solve complex optimization problems and utilizes a collection of mobile agents as "ants" to perform optimal routing activities.

A.K.Daniel et al. [20] have proposed a Protocol for wireless mobile heterogeneous networks based on the use of path information, traffic, stability estimation factors as signal interference, signal power and bandwidth resource information at each node. This paper deal with the inability of the network to recover in case of networks failure, to reduce the maintenance overhead , increase the path stability, reducing the congestion in MANET by using Ant Colony based routing by introducing a new concept of three ants for path formation, link failure, and control. The protocol considered swarm intelligence based technique for routing in Heterogeneous MANET using Signal interference, Noise, Signal power as link stability factors for QoS. The routing is done with the help of three Ants technique. This implementation improved the QoS guarantee to improve the performance of the network.

Mamoun Hussein Mamoun [21] have proposed a proactive ant based routing approach for MANET inspired by the Ant Colony Optimization paradigm. The algorithm proactively sets up multiple paths between the source and the destination.

Forward ants (FANT) and backward ants (BANT) are used for creating new routes. A pheromone track is established to the source node by a FANT and to the destination node by a BANT. A small packet with a unique sequence number is known as the FANT. Depending upon the sequence number and the source address of the FANT, the duplicate packets can be distinguished by the nodes [22].

QoS support in MANETs includes QoS models, QoS resource reservation signaling, QoS Medium Access Control (MAC), and QoS routing [23]. This paper discusses some key design considerations in providing QoS routing support, and presents a review of previous work addressing the issue of route selection subject to QoS constraints.

Core-Extraction Distributed Ad hoc Routing (CEDAR) algorithm is designed to select routes with sufficient bandwidth resources. CEDAR dynamically manages a core network, on which the state information of those stable high bandwidth links is incrementally propagated. CEDAR selects QoS routes upon request [24].

A number of successful ant-based routing algorithms exist for wired networks, and are based on the pheromone trail laying-following behavior of real ants and the related framework of Ant Colony Optimization (ACO). Ant based routing algorithms exhibit a number of desirable properties for MANET routing: they work in a distributed way, are highly adaptive, robust and provide automatic load balancing. AntNet is an algorithm conceived for wired networks, which derives features from parallel replicated Monte Carlo systems, previous work on artificial ant colonies techniques and telephone network routing [25]. The idea in AntNet is to use two different network exploration agents (forward and backward ants), which collect information about delay, congestion status and the followed path in the network.

Ant based Control (ABC) is another ant based algorithm designed for telephone networks. It shares many similarities with AntNet, but also incorporates certain differences [26]. The basic principle relies on mobile routing agents, which randomly explore the network and update the routing tables according to the current network state.

AntHocNet is based on ideas from Ant Colony Optimization [27]. AntHocNet uses end-to-end delay as a metric to calculate congestion at a node, which may not yield accurate results as end-to-end is affected by both congestion as well as the length of the route from source to destination. ANSI (Ad hoc Networking with Swarm Intelligence) is a congestion-aware routing protocol, which, owing to the self-configuring mechanisms of Swarm Intelligence, is able to collect more information about the local network and make more effective routing decisions than traditional MANET protocols. ANSI is thus more responsive to topological fluctuations [28].

A unicast on-demand routing protocol Swarm-based Distance Vector Routing (SDVR) is proposed to optimize three parameters delay, jitter, and energy[29].Ant-like agents are used in this algorithm to discover and maintain paths with the specified QoS requirements in Ad hoc On demand Distance Vector routing (AODV) protocol. SDVR produces better performance than AODV in terms of packet delivery ratio, end-to-end delay, energy, and jitter.

A network or service provider can offer different kinds of services [30] to users which can be categorized a set of measurable prespecified service requirements such as minimum bandwidth, maximum delay, maximum delay variance (jitter), and maximum

packet loss rate. After accepting a service request from user, network has to ensure that service requirements of user's flow are met, as per the agreement, throughout the duration of flow.

As discussed in [31], several researchers [32, 33] addressed general problem of QoS in MANETs, providing overviews and insights on the work being done in this area. To achieve QoS provisioning, QoS routing algorithms normally integrate QoS provisioning into routing protocols.

The QoS version of AODV (QoSAODV) [34] Core-Extraction Distributed Ad Hoc Routing (CEDAR) protocol [35] and Multimedia Support for Mobile Wireless Networks (MMWN) protocol [36] are some of the examples of QoS routing algorithms proposed for MANETs. However, QoS signaling techniques are independent of underlying routing protocols.

The In-band signaling for QoS in Ad-Hoc Mobile Networks (INSIGNIA) algorithm [37] is a typical signaling protocol designed exclusively for MANETs. The idea of CEDAR and MMWN is to broadcast link-state information across the network in order to enable other nodes to find routes that meet QoS criteria, like minimum bandwidth. On the other hand, INSIGNIA piggybacks resource reservations onto data packets, which can be modified by intermediate nodes to inform the communication endpoint nodes in case of lack of resources. These approaches are based on the idea that wireless links between mobile nodes have certain

V. ISSUES RELATED TO ANT BASED ROUTING

Routing for MANET focuses on guarantees with respect to bandwidth, cost and delay. Several techniques were proposed in ACO, but it had certain drawbacks:

1. The mathematical and engineering problems can be solved in the existing ant based approaches. Though the nodes in the networks have different transmission ranges, ARA can find routing paths that are close to the shortest path. But here energy is not taken into account [15].
2. In POSNET, new ant colony based routing algorithm, the information of the position of nodes helps to increase the efficiency of ant routing. But it doesn't consider energy in routing [16].
3. Node connectivity and end to end delay is increased using Multi agent routing algorithm but complex optimization problems are not considered [17].
4. Multi-path Dynamic Source Routing with Cost and Ant Colony Optimization system provide user choice based route discovery process, Cost based route estimation, but this does not enable fast routing with better packet delivery ratio (PDR) [18].
5. The total overhead is reduced to some extent in the efficient ant routing protocol. To discover a route to the destination node it resumes its route discovery process from the place where it ended in the last round following a failure. More energy is consumed because of this routing process [19].
6. The packet delivery ratio and end to end delay of the proactive routing algorithm makes it efficient than the traditional AODV. Though overhead is controlled in this algorithm the routing overhead is decreased only when the AODV performance is stable [21].

VI. CONCLUSION & FUTURE WORK

In this paper, we have focused the domain of the ant the colony optimization framework for routing protocols, because we believe that survey of those protocols which is beneficial for constructing Ant based routing technique.

For the next step of the review about the routing protocols based on Ant based routing would like to follow the different aspects of those protocols such as route congestions and the broadcast behaviors in network performance. Those issues naturally denote the future directions.

In this survey we have over-viewed some recent efforts to develop a theory of ant colony optimization. For each of these different research directions we explicitly listed those that are, in our opinion, some of the most interesting open problem. As the ACO research field is currently flourishing, we expect to see many of these problems solved in the near future. As a final comment, we note that ACO research is not only about theory. On the contrary, most of the field is concerned with experimental work. To the reader that, after learning the theoretical underpinnings of ACO as presented in this synopsis, becomes interested in the more practical aspects of the development of ACO algorithms. In future, the performance comparison can be made between the proposed protocol and the existing protocol for performance metrics such as end-to-end delay, routing overhead, etc. of ad hoc routing protocols with proposed simulation parameters.

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