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Ant Based Techniques for QoS Routing in Mobile Ad Hoc Network: An Overview

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----------**ABSTRACT**----------
Mobile Ad Hoc Network (MANET) is a collection of wireless mobile nodes dynamically forming a temporary network without the use of any existing heterogeneous network infrastructure. Quality of Service (QoS) support for MANET is a challenging task due to dynamic topology and limited resource. The main purpose of QoS routing is to find a feasible path that has sufficient resources to satisfy the constraints. Ant based technique is a stochastic approach for solving optimization problems like routing in mobile ad hoc networks. This technique is based around on the study of collective behavior in decentralized self organized system. In this paper we describe an overview of the research carried out in Ant Based QoS routing for MANET.

Keywords: **Ant based routing, Ant Colony Optimization, MANET, QoS Routing**

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I. INTRODUCTION

The unique characteristics of an Ad Hoc Network differentiate it from other classes of networks. The mobile devices are connected through wireless links that may have several effects such as fading, environmental, obstacles, etc. The devices used to form an Ad Hoc Network possess limited transmission range; therefore, the routes between a source and a destination are often multi hop. As there are no separate routers, nodes that are part of the network need to cooperate with each other for relaying packets of one another towards their ultimate destinations as they do not have central administration, it is easy to deploy and expand. Further it is convenient and increases productivity. As the nodes in the network is Mobile, the topology of network changes unpredictably. Hence it is difficult to generate path between two nodes. The main issues of Ad Hoc Network are challenges in routing due to dynamic network topology and providing consistent quality of service in wireless nodes.

Routing in MANET is a Dynamic Optimization Problem as the search space changes over time. The routing policy is defined as the rule that specifies what node to take next at each decision node to reach the destination node. Due to the time varying nature of the topology of the networks, traditional routing techniques such as distance-vector and link-state algorithms that are used in fixed networks, cannot be directly applied to mobile Ad hoc networks. Centralized algorithms have scalability problems, static algorithms have trouble keeping up-to-date with network changes, and other distributed and dynamic algorithms have oscillations and stability problems. Ant based routing provides a promising alternative to these approaches. Ant-based routing utilizes mobile software agents (Ants) for network management. These agents are autonomous entities, both proactive and reactive, and have the capability to adapt, cooperate and move from one location to the other in the MANET. Ant Colony, in particular, uses stigmergy for agent interaction.

Ant colony boasts a number of advantages due to the use of mobile agents and stigmergy (a form of indirect communication used by ants in nature to coordinate their problem-solving activities). These are [1].

1. Scalability: Population of the agents can be adapted according to the network size. Scalability is also promoted by local and distributed agent interactions.
2. Fault Tolerance: Ant Colony process does not rely on a centralized control mechanism. Therefore loss of a few nodes or links does not result in catastrophic failure, but rather leads to graceful, scalable degradation.
3. Adaptation: Agents can change, die or reproduce, according to network changes.
4. Speed: Changes in network can be propagated very fast.
5. Modularity: Agents act independently of other network layers.
6. Autonomy: Little or no human supervision is required.
7. Parallelism: Agents operations are inherently parallel.

These properties make Ant Colony very attractive for MANET. However, one of the biggest difficulties with ant colony algorithms applied in network routing area is that multiple constraints often make the routing problem intractable [2].

The role of a QoS routing strategy is to compute paths that are suitable for different types of traffic generated by various applications while maximizing the utilizations of

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network resources. But the problem of finding multi-constrained paths has high computational complexity.
The major objectives of QoS routing are

1. To find a path from source to destination satisfying user's requirements.
2. To optimize network resource usage.
3. To degrade the network performance when unwanted things like congestion, path breaks appear in the Network [3].

The rest of the paper is organized as follows. Section II describes the previous Work related to QoS aware routing protocols in MANET. Section III Briefly describes Ant Colony Optimization. Section IV describes Issues Related to Ant Based QoS Routing. Finally conclusion and future work is drawn.

II. RELATED WORK

P.Deepalakshmi et al. [3] 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. [4] 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. [5] 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. [6] 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. [7] 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. [8] 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. [9] 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 [10] 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.

III. ANT COLONY OPTIMIZATION

Combinatorial optimization problems such as routing can be solved using Ant Colony Optimization (ACO) in computer networks. Observing the optimization of food gathering by the ants is the basic idea of this optimization. The foraging behavior of real ants has been implemented by ACO. Initially, the ants walk randomly when multiple paths are available from nest to food. A chemical substance called pheromone is laid by the ants while traveling towards food and also during the return trip. This serves as the route mark. The path which has a higher pheromone concentration is selected by the new ants and that path is reinforced. A rapid solution can be obtained by this autocatalytic effect [3].

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 [11].

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Ant Based Routing Techniques

In Ant based route discovery, the transmission delay of each link, processing delay at each node, the available bandwidth capacity of each link, and the number of hops visited are collected by the ant agents to estimate the path preference probability. Then the route with higher preference probability is established.

The following set of core properties characterizes ACO instances for routing problems:

1. Providing traffic-adaptive and multipath routing.
2. Relying on both passive and active information monitoring and gathering.
3. Making use of stochastic components.
4. Not allowing local estimates to have global impact,
5. Setting up paths in a less selfish way than in pure shortest path schemes favoring load balancing.
6. Showing limited sensitivity to parameter settings [3].

The route from source node to destination node changes in the MANET since it consists of mobile nodes. Detection of dynamic topology, generation of path between nodes and handling route failures are performed by the routing algorithm. It has three phases.

Route discovery phase **–** The route discovery and maintenance is done by flooding the network with ants. Both forward and backward ants are used to fill the routing tables with probabilities. These probabilities reflect the likelihood that a neighbor will forward a packet to the given destination. Also multiple paths between source and destination are created. First of all, neighbors are discovered using HELLO messages, but entries are only inserted in the routing table after receiving a backward ant from the destination node. Each neighbor receives a probable value for destination. This value is increased as a backward ant comes from that node, establishing a path towards destination. As ants are flooded, the algorithm uses sequence numbers to avoid duplicate packets.
Only the greater sequence number from the same previous hop is taken into account. Forward ants with a lower sequence number are dropped [13]. All feasible paths from source node to destination node are found in this phase.

Route maintenance phase **–** The route maintenance phase is responsible for the improvement of the routes during the communication. A route can be invalid due to nodes along the route moving away or a link being broken. The broken link will conduct a local repair procedure, trying to find an alternative path to the destination while buffering all the packets it receives. If the node successfully finds a new path to the destination, it will send all the buffered packets to the destination via the newly found route, meanwhile, a notification ant will be sent to the source to let the source node know the change of route. All nodes on the path that the notification ant visits will update their routing table to remove any invalid routes. The source will replace the related path with the path value in the notification ant. If such an alternative path can not be found, an error ant will be sent to the source node. After receiving the error ant, if the source node still needs a route to the destination, it will initiate a new forward ant to find a route to the destination [14].

Route failure handling **–** This phase is responsible for generating alternative routes in case the existing route fails. Node mobility in Ad Hoc Network may cause certain links to fail. Every packet is associated with acknowledgement, hence if a node does not receive an acknowledgement, it indicates that the link is failed. On detecting a link failure the node sends a route error message to the previous node and deactivates this path by setting the pheromone value to zero. The previous node then tries to find an alternate path to the destination. If the alternate path exists, the packet is forwarded on to that path else the node informs its neighbors to relay the packet towards source. This continues till the source is reached. On reaching the source, the source initiates a new route discovery phase. Ant algorithm provides multiple paths. If the optimal path fails, it leads to choosing next best path. Next best path will be that path with links having next highest pheromone value (second best path). Hence ant algorithm does not break down on failure of optimal path [12].

IV. ISSUES RELATED TO ANT BASED QOS ROUTING

QoS 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 [4].
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 [5].
3. Node connectivity and end to end delay is increased using Multi agent routing algorithm but complex optimization problems are not considered [6].
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) [7].
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 [8].
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 [10].

V. CONCLUSION

It is desirable that an Ad Hoc Network has a provision of QoS. However, the provision of QoS in MANET is a challenging task. In this paper, we present a review of the

current research related to the provision of QoS in an Ad Hoc Networking environment. We discuss issues involved in providing QoS in an Ad Hoc Network.

From the existing and recent work , we can conclude that many techniques were proposed based on ant based routing protocol which can effectively find the globally best solution in terms of routing for a given Ad Hoc Network. Few existing techniques consider the QoS requirements and bandwidth considerations for the transmission of data. Few other ant based techniques find a solution for better node connectivity. Further work on QoS in MANET can be extended with soft computing techniques.

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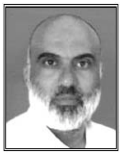

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