

A Survey of ANT Based Routing Algorithms for MANETs Towards Improved Quality of Service

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Abstract: Mobile ad hoc network (MANET) is a group of mobile nodes which communicates with each other without any supporting infrastructure. Routing in MANET is extremely challenging because of MANETs dynamic features, its limited bandwidth and power energy. MANET nodes operating on battery try to pursue the energy efficiency heuristically by reducing the energy they consumed. Ant Colony Optimization are more predicting in providing loop free, energy-aware, and multipath routing in mobile ad hoc networks. ACO routing algorithms use simple agents or artificial ants and these agents demonstrate optimum paths between source and destination. These agents communicate indirectly with each other by means of stigmergy. This paper determines a survey on different MANET routing protocols which are based on algorithm inspired by ACO.

Keywords-Ant Colony Optimization, Quality of Service (QoS) routing.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a decentralized group of mobile nodes which alternate data temporarily by the use of wi-fi transmission [1]. Given that the nodes are cellular, the network topology may change quickly and unpredictably over time. The network topology is unstructured and nodes may enter or go away at their will. A node can be in contact to other nodes which are within its transmission range. This sort of community guarantees many advantages in terms of cost and adaptability in comparison with community with infrastructures. MANETs are very suitable for a best kind of applications comparable to data collection, seismic pursuits, and medical applications.

Applications of MANET in several areas include: Commercial sectors, personal area network, collaborative and distributed computing, wireless sensor network, wireless mesh network and hybrid wireless network architectures. MANET works with different routing protocol as compared to fixed networks. Ant Colony optimization (ACO) based Algorithms finding optimal paths that are based on the behaviour of ants path searching capability. ACO uses swarm intelligent methods and comprise some heuristic optimizations techniques. Optimization problems are of

high importance both in the industrial world and in the scientific world. Ant Colony Optimization (ACO) takes inspiration from the behavior of ant's. Ants deposit pheromone on the ground in order to mark the favourable path that should be followed by other members of the colony. Ant Colony Optimization exploits a similar mechanism for solving optimization problems. Many ants can take different routes for searching for the same food source. The ants, which take the shortest path, reinforce that path with more quantity of pheromone which helps other ants to follow that shortest path. More number of other ants is getting attracted because of this pheromone trail which makes the path stronger.

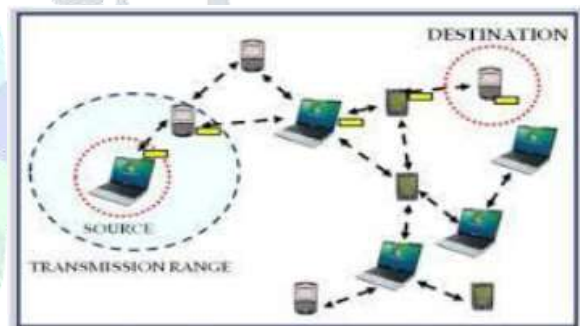


Fig 1: Mobile AdHoc Network (MANET)

II. RELATED WORK

A Probabilistic Emergent Routing Algorithm for MANETs (PERA) which presented in [5] is a proactive routing algorithm for MANET based on the swarm intelligence paradigm and similar to the swarm intelligence algorithms. The algorithm uses three kinds of agents, regular forward ants, uniform forward ants and backward ants. Uniform and regular forward ants are agents (routing packets) that are of unicast type. These agents proactively explore and reinforce available paths in the network. They create a probability distribution at each node for its neighbours. The probability or goodness value at a node for its neighbour reflects the likelihood of a data packet reaching its destination by taking the neighbour as a next hop.

Backward ants are utilized to propagate the information collected by forward ants through the network and to adjust the routing table entries according to the perceived network status. Nodes proactively and periodically send out forward regular and uniform ants to randomly chosen destinations. Thus, regardless of whether a packet needs to be sent from a node to another node in the network or not, each node creates and periodically updates the routing tables to all the other nodes in the network. The algorithm assumes bidirectional links in the network and that all the nodes in the network fully cooperate in the operation of the algorithm.

A new proactive routing algorithm for MANET (NPR) [6] is proactively sets up multiple paths between the source and the destination. The two factors that affect the performance of a probabilistic algorithm are exploration and exploitation. In a dynamically changing topology of the MANETs where there are frequent link breakages due to node mobility, an optimal balance between exploration and exploitation is required. More emphasis on exploitation will cause the probabilities of few routes

to saturate to 1 and the probabilities of other routes to saturate to 0. As a result new routes will never be discovered. Author suggested a modification of the state transition rule in ACO to balance exploration and exploitation. According to the modified rule, the ants may be unicast or broadcast at a node depending

on the route information. If the route information to the destination is present, the ants are unicast, otherwise it is broadcast.

PACONET [7] is a reactive routing protocol for MANETs inspired by the foraging behaviour of ants.

It uses the principles of ACO routing to develop a suitable problem solution. It uses two kinds of agents: Forward ants (FANT) and Backward ants (BANT). The FANT explore the paths of the network in a restricted broadcast manner in search of routes from a source to a destination. The BANT establishes the path information acquired by the FANT. These agents create a bias at each node for its neighbours by leaving a pheromone amount from its source. Data packets are stochastically transmitted towards nodes with higher pheromone concentration along the path to the destination. FANTs also travel towards nodes of higher concentration but only if there exists non visited neighbour node in the routing table. This algorithm focuses on efficiency and effectiveness of the approach as a solution to the routing problem in a simulated adhoc environment.

PBANT [8] 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 neighbours and the position of the destination) can be obtained by positioning instruments such

as GPS receiver to improve routing efficiency and reduce the algorithm overhead. PBANT is basically ARA where position details of the nodes are known in advanced. PBANT is a robust, scalable reactive routing algorithm suitable for MANETs with irregular transmission ranges.

Ant-E [9] proposed by Sethi and Udgata is a novel metaheuristic on-demand routing protocol, using the Blocking Expanding Ring Search (Blocking-ERS) to control the overhead and local retransmission to improve the reliability. Blocking-ERS does not resume its route search procedure from the originating source node when a rebroadcast is required if the destination is not found. There broadcast can be generated by any appropriate intermediate node instead of originating source node.

The rebroadcast can be performed on behalf of the originating source node act as relay. This method enhances the efficiency of MANET routing protocol. Ant-E is used to solve complex optimization problems and utilizes a collection of mobile agents as “ants” to perform optimal routing activities.

Ant-AODV [10] forms a hybrid of both ant-based routing and AODV routing protocols to overcome some of their inherent drawbacks. The hybrid technique enhances the node connectivity and decreases the end-to-end delay and route discovery latency. Ant-AODV ant agents work independently and provide routes to the nodes. The nodes also have the capability of launching on-demand route discovery to find routes to destinations for which they do not have a fresh enough route entry. The use of ants with AODV increases the node connectivity (the number of destinations for which a node has un-expired routes), which in turn reduces the amount of route discoveries even if a node launches a RREQ (for a destination it does not have a fresh enough route), the probability of its receiving replies quickly (as compared to AODV) from nearby nodes is high due to the increased connectivity of all the nodes resulting in reduced route discovery latency. As ant agents update the routes continuously, a source node can switch from a longer (and stale) route to a newer and shorter route provided by the ants. This leads to a considerable decrease in the average end-to-end delay as compared to both AODV and ant-based routing. Ant-AODV uses route error messages (RERR) to inform upstream nodes of a local link failure similar to AODV.

ARAMA [11] is a combination of on demand and table driven algorithms proposed by Hossein and Saadawi. The main task of the forward ant as in other ACO algorithms for MANETs is to collect path information. However, in ARAMA, the forward ant takes into account not only the hop count factor, as most protocols do, but also the links local heuristic along the route such as the node's battery power and queue delay. ARAMA defines a value

called grade. This value is calculated by each backward ant, which is a function of the path information stored in the forward ant. At each node, the backward ant updates the pheromone amount of the node's routing table, using the grade value. The protocol uses the same grade to update pheromone value of all links. It focuses on optimizing different Quality of Service parameters, other than number of hops. Such parameters include energy, delay, battery power, mobility etc. ARAMA proposed a path grading enforcement function that can be modified to include these QoS parameters. One of the important attributes of this algorithm is that the lifetime of the ad hoc nodes have been extended by using a fair distribution of energy across the network.

HOPNET [12] based on ants hopping from one zone to the next is highly scalable for large networks compared to other hybrid protocols. The algorithm has features extracted from ZRP and DSR protocols. The HOPNET algorithm consists of the local proactive route discovery within a node's neighbourhood and reactive communication between the neighbourhoods. The network is divided into zones which are the node's local neighbourhood. The size of the zone is not determined locally but by the radius length measured in hops. Therefore, a routing zone consists of the nodes and all other nodes within the specified radius length. A node may be within multiple overlapping zones and zones could vary in size. The nodes can be categorized as interior and boundary (or peripheral) nodes. Boundary nodes are at a distance from the central node. All other nodes less than the radius are interior nodes. Each node has two routing tables: Intrazone Routing Table (IntraRT) and Interzone Routing Table (InterRT). The IntraRT is proactively maintained so that a node can obtain a path to any node within its zone quickly.

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

A first example of a SI based algorithm for QoS routing is the AntNet+SELA [13]. It is a model for delivering both best-effort and QoS traffic in ATM (connection-oriented) networks. It is a hybrid algorithm that combines AntNet-FA with a stochastic estimator learning automation at the nodes. In addition to same best-effort functionalities that have in AntNet-FA, the ant-like agents serve for the purpose of gathering information which is exploited by the automata to define and allocate on-demand feasible paths for QoS traffic sessions. Ant colony based Multi-path QoS-aware Routing (AMQR) [14] used ants to set up multiple link disjoint paths. The source node stores information about the paths followed by different ants, and combines it to construct a topology database for the network. Based on this database, it

calculates n different link disjoint paths, and it sends data packets over these different paths. Pheromone is updated by the data packets.

Swarm-based Distance Vector Routing (SDVR) [15] a straight forward on-demand implementation of an AntNet scheme that uses multiple pheromone tables, one for each different QoS parameter, and combines them at decision time. A pheromone evaporation mechanism is used to reduce the attractiveness of old paths. SDVR systematically outperforms AODV in small networks.

An Effective Ant-Colony Based Routing Algorithm (AMQRA) [16] for MANET, which deals with the routing in 3 steps: routing discovery, routing maintenance and route failure discovery. In this routing scheme, each path is marked by path grade, which is calculated from the combination of multiple constrained QoS parameters such as the time delay, packet loss rate and bandwidth. For route failure the algorithm suggests when a node receives wrong messages, first it set the pheromone value to zero, and then the routing table is searched. If there are alternate routes to the destination node, data packets would be sent by the new routes else an ERROR messages are sent via inverse routing to inform upper nodes, and the upper nodes will delete failure route.

In [17] presented an overview of the research related to the provision of QoS in MANETs also discussed methods of QoS at different levels including those at the levels of routing, Medium Access Control (MAC), and cross layer. ARQoS [18] is an on-demand routing protocol for MANET, where the routing table of ARQoS maintains an alternate route to the specified node by considering the bandwidth requirement of the source node. The route is discovered by calculating the corresponding QoS provision parameter (bandwidth) to find the primary route and the alternate route from the source node to destination.

ARQoS can significantly reduce end-to-end delay and increase packet delivery ratio under conditions of high load and moderate to high mobility. Protocol proposed in [19] 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 protocol 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 swarm intelligence based routing by introducing a new concept of three ants for path formation, link failure and control.

III. CONCLUSION

A number of Ant Colony optimization algorithms are used for routing in MANET. Diverse net based MANET protocols are studied under various categories like Proactive protocol, Reactive protocols and Hybrid protocols. The agents in Ant colony Routing algorithms communicate indirectly through the stigmergy and provide positive feedback to a solution by laying pheromone on the path. This paper benefit in identifying the main focus of each algorithm i.e. the main key point involved in developing that algorithm.

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