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Intelligent Structured Self Optimizing ACO based Routing for MANET

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Abstract - **In general, the problem in routing is of specifying path flows to proceed incoming data traffic so that the overall network performance is optimized. At each node data is forwarded according to a parameter mentioned in routing table. The path finding algorithm starts when a data packet needs to be sent from a starting point to an end. Goal of routing is to find shortest path. Routing in Mobile Ad-hoc Networks affected from frequent topology change, as Mobile Ad-hoc networks are dynamic in essence, so the node changes their physical location by moving around and it is difficult to design effective routing algorithms. An on-demand routing method is a famous routing category for wireless ad-hoc routing. It is a comparatively new routing idea that provides a scalable solution to comparatively large network topologies. The goal of our proposed system, we named it as Intelligent Structured Self-Optimizing Ant Colony Optimization Routing (ISSOACOR), is to design a new adaptive routing technique for finding an optimized route in Mobile Ad-hoc Networks which is reactive. This routing protocol combines ideas from Ant Colony Optimization routing with techniques from dynamic programming and local retransmission. We will use local retransmission to advance the reliability in term of packet delivery ratio. This method will enhance the efficiency of MANET routing protocol as energy consumption is minimum. We will calculate packet delivery ratio, end to end delay, average throughput and energy consumption. This work illustrate the importance in carefully evaluating and implementing routing protocols in an ad hoc environment .**

Index Terms— Routing, Mobile Ad-hoc Network, Ant Colony Optimization .

I. INTRODUCTION

A wireless Swarm Intelligence is a part of Computational Intelligence. It provides better solution for complex optimization problem. These problems are not simply tackled by other approaches so swarm intelligence can be used. Swarm Intelligence mainly consists of Ant Colony Optimization, Particle Swarm Optimization and Honeybees paradigms. Swarm Intelligence approaches are based on nature and bio inspiration. It is collective behavior of decentralized, self-organized and self decision making systems. Swarm intelligence systems are typically made up of a population of simple agents like insects interacting locally with one another and with their environment [5] or community. A swarm is defined as a set of agents that jointly work out over the problems. Swarm Intelligence approach is most appropriate for the routing and energy resources optimization related issues in MANETs and WSNs.

A. Ant Colony Optimization

Ant Colony algorithm is one of the Swarm Optimization Algorithm techniques. Ant Colony algorithm aims to find for an optimal shortest and reachable path in a graph. Here, the graph is drawn based on the behavior of the ant, which finds a path and the source of food. The nature gives us a result to find the shortest path. The ants/agents in their necessity to find food and brings it back to the nest manage not only to explore a huge area but also to indicate to their peers the position of the eatable while bringing it back to the nest [5]. Usually ants are taken their eatable and returning to their colony by dropping some pheromone trails in their path from where it taken the eatable to nest. This pheromone trails leads to find the shortest path between the eatable source and the nest [15]. So they know where their nest is and also their target without having a global view of the ground. Most of the time, they find the shortest path and adapt to ground changes hence proving their great efficiency toward this difficult task [5].The ant lives for the colony and exists only as a part of it. Each ant is capable to communicate, cooperate, learn, and all together they are able of developing themselves and colonies a large area.

Pheromone is one kind of memory for ants. The fact that it is external and not a part of the ants/agents/insects grant to it as an easy access for everyone. The memory is can be saved in without regarding the configuration of the ground, the number of ants etc. It is fully independent and even though it remains extremely simple [5]. Pheromones just proceed to one task; nature will take care of it in the real life, although it is a simple process in algorithms. In course of time a overall reduction of the pheromones by a certain factor is utilized, simulating the evaporation process. Thus the non-accomplished path will see their concentration of pheromones reduced even if good solutions will stay full of pheromones as the ants keep using it [5].

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Stigmergy is an approach of indirect communication between the events and the agents /ants[15]. They are in the form of self organized. It produces compound, apparently intelligent structures, without need for any control, planning, or even direct communication between the agents/ants. So, it supports the efficient and effective collaboration between the simple agents who lacks in any memory or individual alertness of each other [15].

B. Routing

Routing is at the root of any network control system. In general the routing problem is the problem of defining path flows to forward incoming data traffic such that the overall network performance is maximized. At each node data is forwarded according to a decision protocol parameterized by a local data structure called routing table. Source node or starting node is the node from where traffic flow starts and destination or sink or target node is the node where traffic low ends. Data traffic originates from one node and directed to another node i.e. unicast, if directed to set of other nodes i.e. multicast, if directed to all other nodes i.e. broadcast. Route finding algorithm starts when data packets need to be sent from source to target.

C. Mobile Ad-hoc Network

MANET is an infrastructure-less network that is consist of wireless mobile computing devices. In MANET, the nodes communicate via wireless links. Each node has a limited transceiver range to transfer and receive the data . All the links in the network are bi-directional. They characterized with a bandwidth. In MANET, network topology is varying that is dynamic, because the connectivity among the nodes is changing. As nodes are moving they are dynamic. While moving, the nodes can stay connected to other nodes but they can also be connected even completely without neighbors.

There are many routing difficulties in MANET.
1) Unpredictable dynamic changes in topology, which is caused by the arbitrary movement and participation of the member nodes.
2) Decentralized control as each node has to maintain the route locally with only partial network information.
3) Limited energy of the mobile node.
Due to these difficulties, a routing protocol should not create high control overhead due to limited bandwidth and energy despite the need of control mechanisms for handling the Network dynamics [5].

II. LITERATURE REVIEW

The ant colony algorithm has strong robustness as well as good distributed calculative mechanism and is easy to combine with other methods and the well performance has been shown on resolving the complex optimization problem. Following are some reviews.

DAR (2008) i.e. Distributed Ant Routing is suitable with critical connectivity [13]. Traditional MANET protocols were ineffective in case of criticality. The simplicity, flexibility and robustness of DAR are always required and demanding features [13].DAR gives better performance from the point of view of the signaling load and the convergence time[13].

The HOPNET (2009) algorithm involves characteristics of Zone Routing Protocol. This algorithm has features from ZRP and DSR protocols. It has two routing tables, Intrazone Routing Table (IntraRT) and Interzone Routing Table (InterRT) [2]. IntraRT is a routing table developed and maintained proactively by HOPNET. InterRT is a responsible routing table for storing routes to a destination out of its zone or region i.e. when a node fails to find the destination within its zone in the IntraRT table. There are four elements in the routing table for a particular (row, column) pair: Pheromone, Visited times, Hops, SeqNum. The pheromone value gets updated by the ants or agents as they traverse the links.

It is highly scalable for large networks. It is able to find multiple paths from any source to a particular target. Optimal path can be chosen thereafter. It has high overhead [2].

iACO (2010) is based on metaphor of ant eatable/food foraging behavior into network routing system [6]. In iACO algorithm each packet is played as an individual ant/agent, communicating with each other via pheromone values stored in each wireless sensor nodes pheromone table.

Two categories of ants are in use, they are termed as forward ants(FA) and backward ants(BA). The forward ants are defined as the ants that are sent from the source. The forward ants will carry the information such as required sensor type, sensor region of interest, data rate and the time period of the interest. The algorithm is partly based on the efficient Max-Min algorithm and it is suitable for flexible structure of wireless sensor networks. This routing scheme performs generally not worse than

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other standard routing algorithm, and in some occasions, it outperforms than min-hop algorithm [6].

The algorithm is a reliable, nature and bio-inspired routing algorithm. It is energy efficient and flexible for wireless sensor network [6].

Ant-DYMO (2010) is a hybrid protocol. It uses an ant-based approach in its proactive phase while DYMO is the basis for the reactive one. So it was possible to improve the latency and increase the network connectivity [7]. Ant-DYMO defines two types of artificial ants: explorer ant (EANT), responsible for creating routes to its source and search ant (ARREQ), responsible for searching for a specific target. EANTs carry the information on the destination node and create (or enforce) pheromone trails along the way. The EANTs carry the address of the source node and also a list containing every intermediate node it has passed [7]. ARREQ has main goal to search for a specific destination, and it inherits the format of DYMOs RREQ, adding a probabilistic search mechanism that takes into account the level of pheromones on the paths [2]. Ant-DYMO is a hybrid and multi-hop algorithm. Nodes acquire information on their neighborhood by the limited flooding of Hello messages[7].

Ant-DYMO protocol is superior to DYMO regarding the effective packet delivery in a smaller amount of time. This protocol directly influences its performance by tuning its configuration parameters [7].

Ant-E (2010) contains a special routing table, in which each destination or target is associated to all interfaces and each interface has a certain probability [14]. Ant-E ensures that routing paths are free from loops, and does not require extra overhead of sequence number to prevent loops. Nodes can find out and recognize duplicate receipt of data packets, based on the source address and the sequence number [14].

This protocol is efficient, reliable and effective as it improves the packet delivery ratio (PDR). Ant-E routing protocol uses blocking ERS and local retransmission along with principles of ant colony to reduce the end-to-end delay and NRL. It enables optimal path routing and fast route discovery with better PDR and Delay [14].

AD-ZRP (2011) is a self-configuring and multi-hop reactive routing protocol based on the HOPNET algorithm. With the robustness of HOPNET, the approach handles important problems in ad hoc networks to improve the discovery and maintenance of routes through ACO and ZRP features [10]. AD-ZRP is proposed as a reactive routing protocol to avoid sending ants periodically into their zones and thus bringing additional overhead to the sensor network [10]. AD-ZRP has two kinds of ants: internal transport ant (ITA) and exploratory transport ant (ETA). Although each ant category has a different function, they share a common data structure [10].

This algorithm is better in terms of data delivery ratio, routing overhead, and congestion avoidance for environments of dynamic topology. It reduces the overhead about the amount of control packets from the network to require less effort in communication [10].

SAHR (2012) i.e. Swarm Adaptive Hybrid Routing balances all the nodes in the network using swarm intelligence [11]. A major gap among Swarm Agent Optimized routing algorithms is that SAHR is a mixture of algorithms. It is immediate in a way that the nodes simply conjugate routing material for target ends which they are at present conversing with, whereas the nodes seek to preserve and advance routing material providing conversation continues. The routing material attained through circuitous member interface educating is broadened among the nodes of MANET in a hop stage adjacent data swap procedure in order to present resultant management for the swarm members [11].

SAHRs performance is better as its overhead increases slowly. It gives better performance in case of peer-to-peer delay and delivery ratio [11].

TABR (2013) i.e. Two Agent Based Routing algorithm uses a single queue at each node to process both data packets and ant packets. Data agent carries the data and routing agent consists of forward and backward.

It is the best routing technique amongst the other two, as it has separate agent to prepare the routing table with the help of forward and backward ant, and a separate agent to carry the data. When the entry in the routing table already exists, data process will simply carry the data to the destination without making the use of routing process. So it reduces the network congestion and so helps in fast routing.

As Distributed Ant Routing algorithm is specially developed for critical connectivity, it minimizes

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overheads and makes fast communication establishment but the energy is main issue in this algorithm. Energy constraints at each node are node considered. But in MANET It is quit necessary to conserve energy. In case of HOPNET algorithm, it is highly scalable for large network. Using HOPNET, we can find multiple paths from source to destination. So that optimal path can be found thereafter. But in HOPNET algorithm we have to maintain two routing table. It maintains only single path after optimization. And as zones are fixed, so cannot support for dynamic zones. The main challenges of routing for WSN are to support data communication while trying to increase the lifetime of node's battery, prevent connectivity loss, decrease congestion, and improve energy efficiency. But HOPNET is not suitable for WSN as it cannot satisfy these challenges. In

III. PROPOSED SYSTEM

The objective of this paper is to design a new adaptive routing technique for finding an optimized route in Mobile Ad-hoc Networks. This routing protocol will combine the ideas from ACO routing with techniques like dynamic programming and local retransmission. It will calculate throughput, end to end delay and energy.

Our proposed system ISSOACOR (Intelligent Structured Self-Optimizing Ant Colony Optimization Routing) system is a multi-path routing model, which represents the ants behavior in the ant colony in Manet's. The objective of this paper is to design a new adaptive routing technique for finding an optimized route in Mobile Ad-hoc Networks. This routing protocol will combine the ideas from ACO routing with techniques like dynamic programming and local retransmission. It will calculate throughput, end to end delay and energy.

Every packet is divided into two parts i.e. data and routing packets. Routing packets will search route and based on this route data packet will be transmitted from source to destination. So our ISSOACOR system will work on two agents i.e. data agent and routing agent will work in three phase's route discovery, route maintenance and route failure. The data structure of ant contains Ant type, Source, Destination, Length, Sequence Number, packet Length, Start time, Memory. Following figure gives the working of ISSOACOR system.

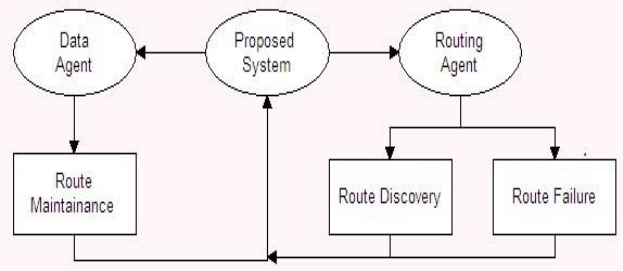

Fig 1: Working of ISSOACOR system

IV. SIMULATION SETTING

We have to implement ISSOACOR protocol using NS2 simulator. A network simulator is a software program that imitates the working of a computer network. In simulators, the computer network is modeled with devices, traffic etc and the performance is checked or analyzed. Typically, users can then customize the simulator to fulfill their specific analysis needs. Ns-2 is a discrete event simulator targeted at networking research. It provides fundamental support for simulation of routing, TCP and multicast protocols over wired and wireless networks. It contains two simulation tools. The network simulator (ns) contains all commonly used IP protocols. The network animator (nam) is used to visualize the simulations. Ns-2 fully simulates a layered network from the physical radio transmission channel to high-level applications. The ns-2 simulator has several features that make it suitable for our simulations.

V. DISCUSSION

Each Link will be bidirectional and weighting value of link will depend on energy consumption, ant's moving time delay and packet delivery ratio. When source node will produce a quantity of forward ants, the destination nodes will randomly chosen by average probability. When one packet will passe through a node by a certain speed, the node will take first step to gather all the ants into buffer storage and then will select the optimal path from its routing table to transfer packets. In this way all the ants will disperse in as many paths as possible to achieve the balance of the load.

CONCLUSION

Our ISSOACOR system will follow the constraints of energy. System will highly scalable as rebroadcasting will be performed by relay node and not by source node in case of route search procedure, if rebroadcast required to

source node. Local retransmission will be held if negative acknowledgement is received. So data packet can retransmit data from intermediate node rather from source node. This will increase effectiveness, efficiency and reliability of network. The behavior of the algorithm, when run in increasingly dynamic environments will show that the ant routing techniques will produce results that are enhanced than the other existing algorithms.

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