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Implementation of Ant Colony Optimization with OLSR in Mobile Ad hoc Network

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Abstract- **MANET is a part of wireless networking which has a collection wireless node which can move one to another place at any time. One of the major research area in the mobile ad-hoc network is the routing. Routing refers to decide the best path for transmit data from one node to other node because topology in MANET cannot be stable. When it comes to MANET, the complexity increases due to dynamic topology, time varying QoS requirements, limited resources and energy etc. QoS routing plays an important role for providing QoS in wireless ad hoc networks. This paper is extending the scope to QoS routing procedure, to inform the source about QoS available to any destination in the wireless network. Here, a new QoS algorithm for mobile ad hoc network has been proposed. The proposed algorithm combines the idea of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) protocol to identify stable paths in between source and destination nodes.**

Keywords: MANET, Ant Colony Optimization, Quality of Service (QoS) routing, OLSR Protocol.

I. INTRODUCTION

The unique characteristics of an Ad Hoc Network differentiate it from other classes of networks. MANET is a collection of mobile devices, which form a communication network with no pre-existing wiring or infrastructure. 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. 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 is a main issue for communication networks. The main problem solved by any routing protocol is to direct traffic from sources to destinations. The demand of quality of service (QOS) is increases day by day .The role of a QoS to compute paths which are suitable for different type of traffic generated when highly use network resources [1]. Wireless communications can be categorized in two networks, Infrastructure dependent and infrastructure independent networks. MANET is one such category of AWN, which has a set of mobile agents, communicating with each other with-in radio frequency range. Radio frequency range is limited, the communication traffic has to be relayed over several intermediate nodes. Therefore, MANET is also known as Multi Hop ad hoc networks. The functionality of the nodes is not only to fulfil as a host, but also as a router to forward packets to other nodes [2].

OLSR is a proactive routing protocol. It is introduced by the IETF MANET working group for mobile ad-hoc networks for stability as well as accuracy. Olsr protocol, have four steps for find the route from source to destination. Neighbor Sensing, MPR Selection, MPR Information Declaration, Routing table calculation**.** . OLSR protocol is the enhanced version of pure link state routing protocol that chooses the optimal path during a flooding process for route setup and route maintenance. The concept used in the protocol is a multipoint relays (MPRs). All the nodes are informed about the subset of all the available links and the link between MPR and MPR selectors. MPRs are select's the nodes who forward and broadcast messages using the flooding process. By using this technique reduces the message overhead as comparison to a simple flooding mechanism, every node again transmits each message when it receives the first copy of the message.
In OLSR, link state information is generated by nodes chosen by MPRs. So, a next optimization is to minimizing the number of control messages in the network. And third optimization, an MPR node elected to report only links between itself and MPR selectors. This information is then used for route calculation.

OLSR uses two kinds of the control messages: Hello and Topology Control (TC). Hello messages are used for finding the information about the link status and the host's neighbours. With the Hello message the Multipoint Relay (MPR) Selector set is constructed which describes which neighbours has chosen this host to act as MPR and from this information the host can calculate its own set of the MPRs. the Hello messages are sent only one hop away but the TC messages are broadcasted throughout the entire network. TC messages are used for broadcasting information about own advertised neighbours which includes at least the MPR Selector list. The TC messages are broadcasted periodically and only the MPR hosts can forward the TC messages.

There is also Multiple Interface Declaration (MID) messages which are used for informing other host that the announcing host can have multiple OLSR interface addresses. The MID message is broadcasted throughout the entire network only by MPRs. The HNA message provides information about the network- and the netmask addresses. The MID and HNA messages are not explained in more details in this chapter, the further information concerning these messages can be found in.

Finding the best path is a complex problem. A possible solution to route dealing with additive and non-additive metrics is to use an optimization technique. Many techniques and algorithms developed to enhance the performance of routing protocol in MANET, but no one is able to find out the answers:

- How to enhance the performance of routing protocol.
- How to find the route between the communication end-points.
- Which path is best for sending data

In this paper we discuss on ant colony optimization for routing protocol in mobile ad-hoc environment which satisfy the Qos requirements. The paper is organized as follows: Section II describe the literature survey of the work. Section III briefly describe the ant colony optimization technique. Section VI we present the proposed solution. Section V takes the simulation environment while the section VI gives the result of the proposed work. At last section VII present the conclusion of this paper.

II. LITERATURE SURVEY

QoS support in MANETs includes QoS models, QoS resource reservation signalling, QoS Medium Access Control (MAC), and QoS routing [1]. 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 [3]. In [4], the authors described a hybrid routing algorithm for MANETs based on ACO and zone routing framework of bordercasting. A new QoS routing protocol combined with the flow control mechanism has been done in [5]. This proposed routing solution is modeled by ant systems. The proposed routing protocol in [6] uses a new metric to find the route with higher transmission rate, less latency and better stability. P.Deepalakshmi. et.al [7] proposed a new on demand QoS routing algorithm based on ant colony metaheuristic. An algorithm of ant colony optimization for mobile ad hoc networks has been described in [8]. But the QoS issues end-to-end delay, available bandwidth, cost, loss probability, and error rate is not considered in [8].

III. ANT COLONY OPTIMIZATION (ACO)

The foraging behaviour of real ants has been implemented by ACO. Initially, the ants walk randomly when multiple paths are available from nest to food. A pheromone is a chemical substance its 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 [9]. Forward ants (FANT) and backward ants (BANT) are used for creating new routes.[10] 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.[11]

the probability of going to city I to city j is given by:

$$P^k_{ij}(t) = \frac{[\tau_{i,j}(t)]^\alpha \cdot [\eta_{i,j}]^\beta}{\sum_{l\in J^k_i} [\tau_{i,j}(t)]^\alpha \cdot [\eta_{i,j}]^\beta}$$

Where J^k_i is the set of city (i,j) that ant k still has to visit when it is on city i.

The parameter α and β control the relative importance of the pheromone versus the heuristic information η_{ij}.

η_{ij} - is the attractiveness or visibility factor which is the inverse function of the distance d_{ij} between the city i and j,

$\eta_{ij} = 1/d_{ij}$

$\tau_{i,j}(t)$ is the amount of the pheromone on the link between city i and j.

A. Network Routing Using ACO

Mobile ad hoc network routing is a difficult problem because network characteristics such as traffic load and network topology may vary stochastically and in a time varying nature. The distributed nature of network routing is well matched by the multi agent nature of ACO algorithms. The given network can be represented as a construction graph where the vertices correspond to set of routers and the links correspond to the connectivity among routers in that network. Now network route finding problem is just finding a set of minimum cost path between nodes present in the corresponding graph representation which can be done easily by the ant algorithms.

B. General Characteristics of ACO algorithms for routing

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

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

IV. PROPOSED WORK

STEP 1: Let the source node S and destination node D, S has data to send to D with Quality of Service requirements higher bandwidth and less delay. A list of node visited by the ant is called visited node list, this forms the route from the source node to destination node.

STEP 2: Initially choose the source node S, and the visited node list will be initialize to source node S.

STEP 3: The Euclidean distance between the two nodes in the network is at most R, where R is the transmission radius which is equal for all nodes in the network.

STEP 4: Source node S initiates a Path_Request_Ant to destination through all its neighbors which are in 1-hop distance from S. The next hop will be selected with the higher probability of the link,

$$P_{i,j} = \frac{[\tau_{i,j}]^{\alpha} . [\eta_{i,j}]^{\beta}}{\sum_{l \in J_i} [\tau_{i,j}]^{\alpha} . [\eta_{i,j}]^{\beta}}$$

$$\eta_{(i,j)} = \frac{[B]^{\beta}}{k}$$

τ(i,j) → pheromone on the link.

η(i,j) → visibility factor of the link.

B→ Bandwidth of the link.

k → k is a constant used for optimization and lies between 0 and 1

α, ß → are the constant aco optimization constant

STEP 5: When the Path_Request_Ant reaches the destination, it will be converted as Path_Reply_Ant and forwarded towards the original source node, and taking the same path corresponding to the Path_Request_Ant but in reverse direction.

STEP 6: To find the best route our algorithm use the pheromone accumulation by the backward ants laid on links, which depends upon the QoS parameter as:

$$\Delta\tau(i,j) = \frac{B^{\beta}}{k} + \frac{k}{D^{\beta}}$$

Δ τ(i,j) → accumulated pheromone on the link.

B → Bandwidth of the link

D → Delay on that link

STEP 7: The backward ant accumulate the pheromone and also the evaporation of pheromone take place, now we calculate the updated pheromone after the evaporation,

$$\tau_{new} = \rho . \tau_{old} + \Delta\tau$$

STEP 8: The path with the higher path preference probability will be considered as the best path and the data transmission can be started along that path.

V. SIMULATION ENVIRONMENT

The simulation scenario and parameters used for performing the detailed analysis of Ant Colony Optimization on MANET routing protocols. This section describes the how the performance parameters have been evaluated to simulate the routing protocols.

Following files have been used for simulation.
Input to Simulator:-

- Scenario File – Mobile Movement of nodes. (bonnmotion file)
- Traffic pattern file. (tr file)
- Simulation TCL file (tcl file)

Output File from Simulator:

- Trace file
- Network Animator file

Output from Trace Analyzer Program:

- Text file containing output

Generation of Traffic Pattern File:
Ns cbrgen.tcl [-type cbr|tcp] [-nn nodes] [-seed seed] [-mc connections] [-rate rate]> [file name]

Generation of Scenario File:
./bm -f<scenario_file_name> <mobility model> -n <num_of_nodes> -d<duration> -x <maxx> -y <maxy> -h<highest_mobility_speed> -l<lowest_mobility_speed> -p <pause_time> -s<seed>

Trace Analyzer Program: We develop a program in JAVA language for analysing the trace file generated after simulating the TCL network script using the NS-2.34. The trace analyser program reads the trace file and produce the output in the form of text file containing packet delivery ratio, routing load, mac load, and delay.

VI. RESULT

For measurement we consider the two matrix of the mobile ad hoc network i.e. packet delivery ratio (PDR) and end-2-end delay.

Packet Devilry Ratio: It is the ratio between the data packets delivered to the destination and those generated by CBR sources. This evaluates the ability of the protocol to discover routes and its efficiency.

End-2-end delay: End-2-end delay is defined as the time taken for a data packet to be transmitted across an MANET from source to destination.

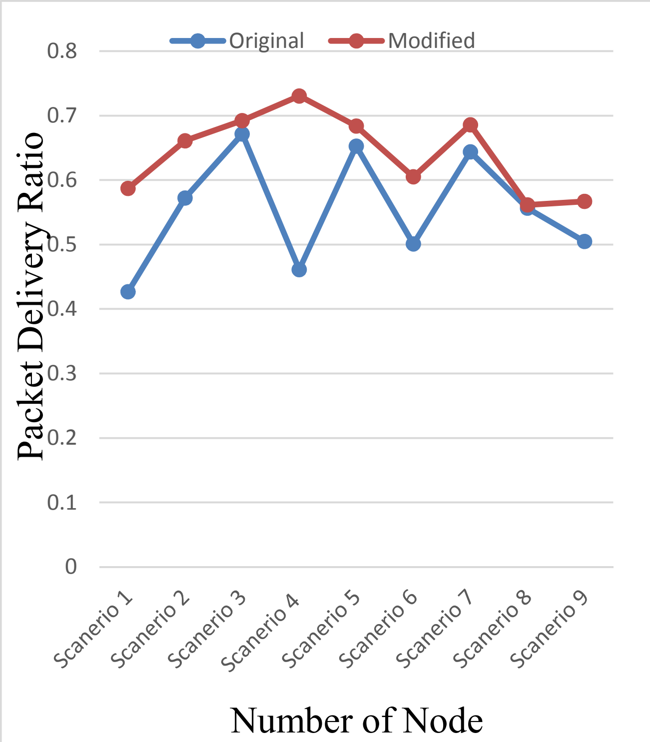

Fig1 Packet Delivery Ratio vs Number of Node

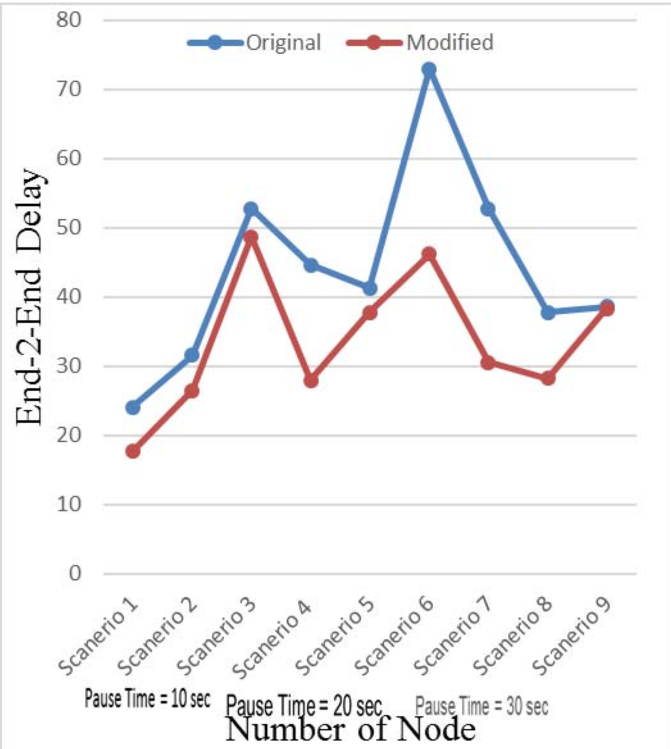

Fig2 End-2-End Delay vs Number of Node

The fig1 shows the packet delivery ratio for the 25, 45, 65 number of nodes with the varying pause time of 10, 20, 30 sec for the original OLSR protocol and modified protocol with the same parameter while fig2 shows the end-2-end delay for the 25, 45, 65 number of nodes with the varying pause time of 10, 20, 30 sec under the original and modified protocol with the same parameter.

VII. CONCLUSION

The simulation result shows that for the node density 25 and 45 the PDR increase with increase in pause time while for node density 65 the PDR decrease with increase in pause time.

Based on our research and analysis of simulation result I draw the conclusion that the approach presented in this paper describes a way to enhance the performance of OLSR routing protocol with the using proposed algorithm using Ant Colony Optimization. The use of Ant Colony Optimization to find the optimum route ensures that the optimum and reliable route has been found out with the greater throughput (packet delivery ratio) and lesser delay.

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