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Effect of ACO Parameters on Optimized Cost of Wireless Network

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Abstract -- **Wireless is playing a major role in the revolution of information technology. The Key challenges in wireless networks are data rate enchancement, minimizing size and cost, low power networking and user security. The biggest challenge is to optimize the cost of wireless network to guarantee a level of performance of data flow. This paper focuses on how to optimize the QOS parameters of wireless networks. The present work will demonstrate how to maximize the throughput and minimize the end to end delay and jitter so as to optimize the cost of the wireless networks. The main goal is to propose an algorithm that increases the performance of the network by reducing the cost of the network.**

I. INTRODUCTION

Wireless network is a collection of mobile nodes which communicate with the help of radio. All networks tend to become more and more complicated with increase in mobile nodes.

In the field of networking, the traffic engineering term known as quality of service (QoS) refers to reservation control mechanisms of resource rather than the achieved service quality. Quality of service is the ability to provide priority to various applications, users, or data flows, or to assure a certain level of performance to a data flow.

QOS metrics are of two types additive and concave. Throughput is the concave metrics whereas end to end delay and jitter are the additive metrics. Finding the best path i.e. the shortest path is a difficult problem. A possible solution to deal with additive and concave metrics is the use of optimization technique.

Ant colony optimization is the approach which has been proposed for solving optimization problems with promising results. Swarm intelligence is the superset of Ant colony algorithms and considers the ability of ants to solve Complex and difficult problems by cooperation. Ants don't use any direct communication for solution process instead they communicate by stigmergy

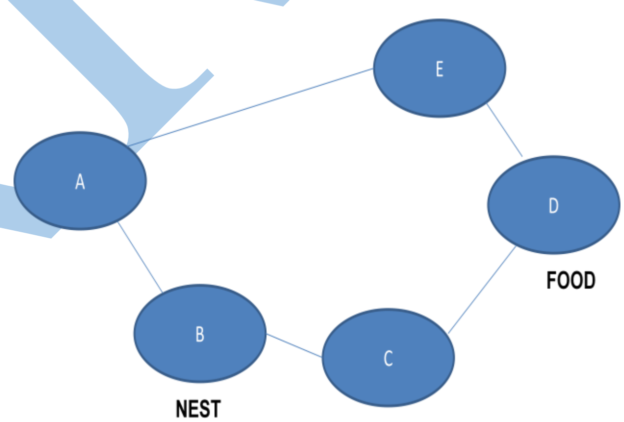
i.e. food searching behavior of real ants. When ants start to search for their food, they start from their nest and walk towards the food. Path searching process depends on this property.

II. ANT COLONY OPTIMIZATION

The ant colony optimization algorithm (ACO) is a probabilistic technique for solving computational problems and finding the shortest paths through tree like structure.

This algorithm belongs to ant colony algorithms family, and it constitutes metaheuristic i.e. multiple iterations optimizations.

Figure1: Adaptation of the Ants-Based Algorithm to Routing Protocols



The main source from where this ACO comes is the behavior that is displayed by species of ants in nature but the difficult task is the cooperation between the ants in the colony. To find out the shortest path Pheromone is used i.e. volatile chemical

substance that is secerated by the ants in order to attract the other ants.

Formulation of ACO

In the Ant Colony Optimization, problems are usually modeled in the form of graph or tree like structure. Let G (E, V) be a graph. Thus the components c_{34} are denoted by either the edges or the vertices of the graph. The objective is to find a shortest path between the source node V_3 and destination node V_4. Each edge of G maintains the value of chemical substance i.e. artificial pheromone concentration over the node and modified whenever an ant travel through it.

Ants will start from B the nest and look for D the food. At every step, they will maintain the routing tables and as soon as the first ant reaches towards their food, the best path known to them and then allows to communicate from D to B.

III. ALGORITHM IN PSEUDO CODE

Initialize Trail
Do While (Stopping Criteria Not Satisfied) – Cycle Loop
Do Until (Each Ant Completes a route) – route Loop
Local Trail Update
End Do
Analyze Routes
Calculate routing metrics
Global Trail Update
Daemon action (optional)
Calculate cost
End Do

IV. KEY PARAMETERS

Trail intensity τ_{34} which indicates the intensity of the pheromone on the trail segment.

Trail visibility is $\eta_{34} = 1/d_{34}$

The importance of intensity is given by α

The importance of visibility is given by β

The trail persistence or evaporation rate is given as ρ

Edge selection

An ant is a simple communicating agent who communicates indirectly in the ant colony optimization algorithm. It iteratively constructs a solution to any type of problem whereas solution states are given by intermediate solutions and in this algorithm, each iteration ant moves from colony to food in order to complete the intermediate solution. Thus, each ant computes a set of feasible solutions. For ant n, the probability p of moving from one state to another i.e. from state 3 to state 4 depends on the combination of two values, the attractiveness η_{34} of the move, and the trail level τ_{34} of the move.

The n^{th} ant moves from state 3 to state 4 with probability i.e. the probability of moving towards next node is given by

$$p_{34}^{n} = \frac{\tau_{34}^{\alpha}\times\eta_{34}^{\beta}}{\sum\tau_{34}^{\alpha}\times\eta_{34}^{\beta}} \qquad (1)$$

V. PHEROMONE UPDATE

When all the ants have completed a solution i.e. reach towards their food from nest then the trails are updated by

$$\tau_{34}^{n} = (1-\rho)\,\tau_{34}^{k} + \Delta\,\tau_{34}^{k} \qquad (2)$$

Where τ_{34}^{n} is the amount of pheromone deposited for a state transition 34, ρ is the pheromone evaporation coefficient and $\Delta\tau_{34}^{k}$ is the amount of pheromone deposited. Performance Metrics When the packet travel

BETA	RHO	DELAY(s) AND JITTER (s)	BANDWIDTH (Hz)	OPTIMIZED COST
1	0.65	40.0022	1422	274
2	0.65	44,0022	1446	262
3	0.65	44.0022	1268	192

form source towards destination then many problems occur:

VI. THROUGHPUT

As the load varies throughput i.e. bit/sec varies because users who share the same network resources so to improve the performance throughput should be maximum.

VII. JITTER

Packets will reach from source to the destination with different delays and this variation in delay is known as jitter and it should be minimum to avoid the affect on the quality of steaming audio or video.

VIII. END TO END DELAY

End-to-end delay is the time taken by the packet to be transmitted across a network from source to destination.

Cost can be evaluated by using these performance metrics is given as

$$Cost = am^{1} + bm^{2} + cm^{3} \qquad (3)$$

Where

m^1, m^2 and m^3 are performance metrics and a, b, c are weight metrics

Simulation model

Cost is evaluated using QUALNET 5.0.2 and MATLAB 7.0. Performance metrics throughput, average end to end delay and average jitter are used to evaluate the cost of the wireless network. Optimized parameters alpha, beta and rho are considered for finding the minimum cost.

Simulation parameters

For the experiment, we have considered different nodes of different difficulty levels. We have tried the different combinations of ACO parameters to get the best optimized result.

The experiment was conducted on different problems at frequency 2.4GHz and data rate 2Mbps.

Table1: Beta =5 and rho = 0.65

Table 1 shows that at beta =5 and rho = 0.65 but with increase in alpha cost increased by 70%.

ALPHA	BETA	RHO	DELAY (s) AND JITTER (s)	BAND WIDTH (Hz)	OPTIMIZED COST
0.2	5	0.65	24.0022	1208	15
0.5	5	0.65	34.0022	1298	133
1	5	0.65	30.0022	1402	355

Table2: Alpha =1 and rho = 0.65

Table 2 shows that at alpha =1 and rho = 0.65 but with increase in beta cost decreased by 70%.

ALPHA	BETA	RHO	DELAY(s) AND JITTER (s)	BAND WIDTH (Hz)	OPTIMIZED COST
1	5	0.1	30.0022	1904	239
1	5	0.2	28.0022	1212	217
1	5	0.3	40	1358	78
1	5	0.4	30	1198	96

Table3: Beta =5 and alpha =1

Table 3 shows that at alpha =1 and beta = 5 but with increase in rho cost varies firstly it decreases and then increases by 70%

IX. CONCLUSION AND FUTURE SCOPE

From the above results it is concluded that wireless network is proposed to optimize three performance metrics i.e. throughput, end to end delay and jitter and determines the optimized cost of the network. Results show that cost reduction is up to 70%. Further it can be implemented using tabu search method and by considering more than three parameters.

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