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Analysis of Hybrid Multipath Routing for Packet Distribution using Ant Colony Optimization

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1 Introduction

With the increasing demand of network communication, a proper and efficient mechanism must be developed to guarantee robustness and does not deteriorate the quality of service(QoS). Many applications that benefit from UDP protocols, however, do not guarantee reliability with the usage of fast transmission. In real time communication which utilize UDP, packets do not get retransmitted if the packets are discarded in the network. This can greatly deteriorate the performance and QoS of the communication session. To enhance the ability of finding the shortest path from *source* to *destination*, a more flexible and effective mechanisms of multipath routing is introduced, one of these is Ant Colony Optimization(ACO). The main idea behinds this intellectual behavior is the use of a volatile chemical substance known as pheromone. Ants move from their nests to a food source following the direction of areas with higher pheromone intensity. Shortest paths can be found quicker and more frequently by ants, and will thus be marked with higher pheromone intensity. These higher pheromone paths will attract more ants, resulting in increased level of pheromone, until there is a convergence of the majority of ants onto this shortest path. By applying this algorithm to routing aspects, we can create a flexible, yet, reliable routing protocol.

2 Objective

With the concept of ACO, the objective of this thesis is mainly the focus of analyzing the effectiveness of ACO and how we can put it into use with the real scenarios both in wired and wireless network.

1. Analysis of the ACO algorithm and the review of implementations and related issues and approaches in actual wired networks through some types of applications/protocols deployment. This objective is laid out and experiment by deploying hybrid ACO implementations in PlanetLab nodes and analyze the quality of packet loss.
2. Implementation of the ACO ideas to different conditions of routing in wireless networks. Taking consideration of node movements and different type of constant bit rates. This can be fulfilled by testing on network simulation NS-2, then compare the result with conventional routing protocols.

3 Implementation and Experiments

The design of the implementation is based on basic algorithm of multipath routing implementation of Ant Colony Optimization. The implementation of hybrid ACO aims to use index factors to prioritize the method of selecting paths for data distributions. ACO consists of different data structures to handle each type of procedure, such as Ant Agents and Pheromone handler. To determine quality of the path, a series of "index factors" needed to use to establish substantial categorization of quality paths. In addition, ACO has a disadvantage of increasing network cost. In fact, by using data packet-like ant agents, additional network resources are required. To solve this problem, a limitation by using node minimization and distance calculations are also put into use. Analysis of results are done with the simulations in two separate environment: simulations on randomly generated number of nodes in wireless networks using NS-2 and evaluation on real networks in PlanetLab Nodes. The evaluation of performance in planetlab nodes can be used to determine how my algorithm actually works inside a real network. However, one of the downside in simulation in this environment is that the ability in changing routing table in normal IP path is limited. In order to cope with the limitation of controlling routing table, we conduct my simulations in NS-2 environment where we can evaluate and analyze how my algorithm responds with the capability of updating routing tables and choosing the right paths for the next destinations.

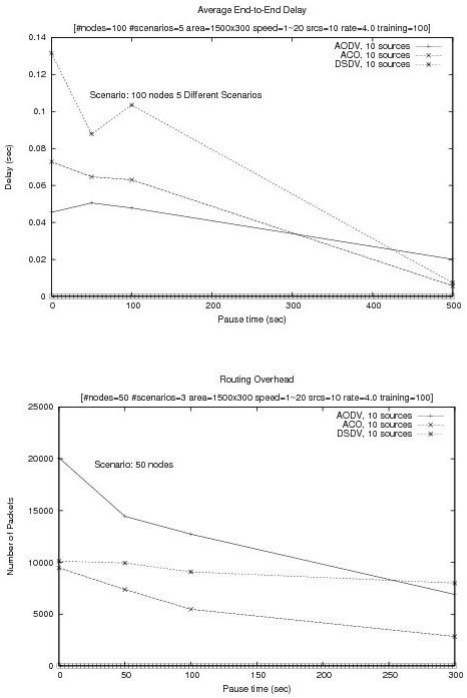

Figure 1. Result of experiments

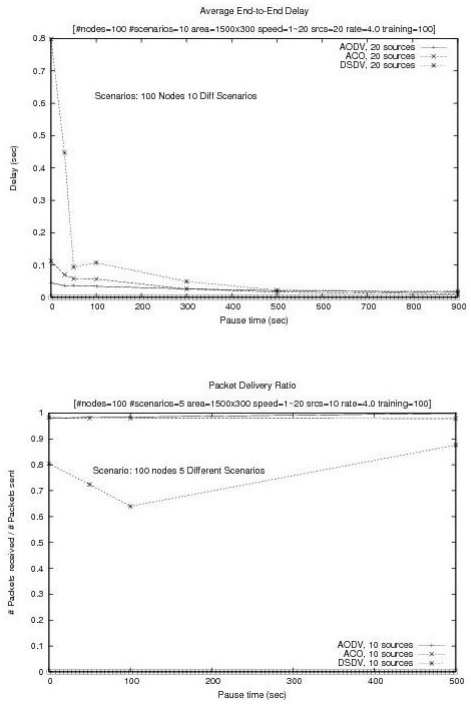

Figure 1. Result of experiments

4 Conclusion

As both simulation have shown in Figure 1, ACO can become quite handy in terms of reducing overall packet loss rate, routing overhead, and performance. Although some tradeoffs, such as average end-to-end delay may be worse than some conventional algorithms, ACO can still be considered as an optional routing protocol which focuses on heavy changes in dynamic networks, or network traffics with high probability of link failures. Since ACO uses the concept of multipath routing, it is highly adaptive and still much more room to be improved. The merits and disadvantages of using ACO regarding the evaluation of results in previous section can be concluded as:

1. ACO reduces packet loss rate in most scenarios, thus achieving more reliability in data distributions.
2. ACO provides less routing overhead compared to other conventional routing protocols according to result in Chapter 5.2 which have been evaluated in different type of scenarios.
3. Number of ant agents can increase depend upon number of nodes inside the networks. However, they can be limited by using regions nodes deduction (Chapter 4.2) or in default declaration.
4. ACO may increase network cost because of its additional usage of data packet-like ant agents. However, these ant agents are rather small data packets and can provide useful information to the routing decisions of packets. Thus, although it is a tradeoff in this algorithm, reducing packet loss ratio is more preferable in most cases.
5. ACO can detect link failures in a proactive way. Meaning, while data distributions are still in sessions, ant agents also explore sample paths. Once link failures occur, ant agents either do not return to the source node, or they use different paths between forward paths and backward paths.

In all, ACO is not something entirely new to the world of science. However, for some computer scientists, it may be a new foundation to something great in the future. With the help of multipath routing and experienced simulations, ACO proves to be a new potential routing protocols with flexible adaptations. I truly hope that the research and simulation I have done in this thesis will take part in improving this ACO algorithm further. With careful implementation and extensive tested, ACO can surely bring in a new era of network communication in the future.