An Overview: An Optimization Solution for Shortest Path Routing Problem

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ABSTRACT
Intelligent analysis and designing of network routing provides an edge in this increasingly fast era. Routing is on the most important issue that has a significant impact on the networks performance. An ideal routing algorithm should strive to find an optimum path for packet transmission within specified time so as to satisfy the Quality of Service (QoS). This paper gives overview of solving shortest path routing problem. It discusses various Quality of Service parameters getting optimized solution.

General Terms
Algorithms, Networking.

Keywords
Shortest path routing, QoS parameter, NN, Genetic algorithm

1. INTRODUCTION
Network optimization is gaining huge importance in recent era. An ideal routing algorithm should strive to find an optimum path for packet transmission within a specified time so as satisfy the Quality of Service [1], [2], [3]. There are several search algorithms for the shortest path problem: the breadth first search algorithm, the Dijkstra algorithm and the Bellman-Ford algorithm, to name a few [4]. Since these algorithms can solve SP problems in polynomial time, they will be effective in fixed infrastructure wireless or wired networks. But, they exhibit unacceptably high computational complexity for real-time communications involving rapidly changing network topologies [2], [3]. This is explained below.

We consider mobile ad hoc networks as target systems because they represent new wireless networks. Since all the nodes cooperatively maintain network connectivity without the aid of any fixed infrastructure networks, dynamic changes in network topology are possible. An optimal shortest path has to be computed within a very short time (i. e. few μs) in order to support time-constrained services such as voice, video and tele-conferencing [1], [3]. The identical algorithms do not satisfy this real-time requirement.

In traditional routing, the goal of the routing algorithm is to find the least-cost path from sender to receiver. QoS routing, on the other hand, has a more complicated goal. There are two main goals that need to be achieved by the QoS routing algorithm [8],[9]. The first goal is to find a path that satisfies the QoS requirements. The second goal is to optimize the global network resource utilization. The second goal is necessary so that the network can accommodate as many QoS requests as possible.

There are various QoS routing algorithms that have been proposed by researchers. Depending on the composition rules of the QoS parameter that the algorithm is supposed to solve, the algorithm may give the exact result or it may be a heuristic. There are three main composition rules: additive, multiplicative and concave. The problem of finding a path subject to constraints of two or more additive and multiplicative metrics is NP-complete. For this type of problem, a heuristic approach must be used. Algorithms in [10] and [11] are heuristics designed to tackle NP-complete problems while algorithms such as in [8] - [13] and [12] are designed solve QoS routing problems that are solvable in polynomial time.

In most of the current packet-switching networks, some form of shortest path computation is employed by routing algorithms in the network layer. Specifically, the network links are weighted, the weights reflecting the link transmission capacity, the congestion of networks and the estimated transmission status such as the queuing delay of head-of-line packet or the link failure. The shortest path problem can be formulated as one of finding a minimal cost path that contains the designated source and destination nodes. In other words, the shortest path routing problem involves a classical combinatorial optimization problem arising in many design and planning contexts [1, 2, 3, 5, 6, 7].

The paper organized as Review of algorithms for shortest path routing is discussed in Section 2. Section 3 described analysis of existing algorithm for solving the problem and conclusion has concluded in Section 4.

2. REVIEW OF WORK

2.1 Dijkstra's Algorithm
Dijkstra's algorithm works by searching the network uniformly and the resulting process can visit a large number of nodes (and links) unnecessarily. One known polynomial optimal solution to this issue, calculates such a constrained shortest path on a modified graph by removing those links without enough bandwidth by using Dijkstra's algorithm.

2.2 BWR-Bandwidth Constrained Routing
Bandwidth-constrained routing (BWR) algorithm [14], which works by combining backwards routing and A* search for fast route selection. The worst-case computation complexity of BWR is deduced to be O(|E|lg|V|), where |E| and |V| represent the number of edges and links in the network, respectively. BWR can greatly reduce the average number of heap operations per route calculation compared with Dijkstra's algorithm. The searching range by BWR increases with offered load because a BWR routing process has to explore longer paths as the number of network links without enough bandwidth resources increases.

2.3 HNN- Hopfield Neural Network
It [3] uses every piece of information that is available at the peripheral neurons, in addition to the highly correlated information that is available at the local neuron, faster convergence and better route optimality is achieved. The

advantage of the Hopfield neural network (HNN) is the hardware-based rapid computational capability of solving the combinatorial optimization problem.

The HNN uses all the information available at the peripheral neurons. Furthermore, it draws on the highly correlated knowledge at the local neuron. In fact, the proposed algorithm strives to employ every piece of information available with the neuron, which counters a tendency to converge to one of the suboptimal paths reachable with only the local information. Thus the corresponding modification allows for speedy and optimal convergence. Its performance is relatively insensitive to variations in network topology. Hardware implementation of the HNN architecture modified with the current proposal can be useful for solving the shortest path routing problems in the rapidly varying network topology as in the emerging mobile *ad hoc* networks.

2.4 Genetic Algorithm

The genetic algorithm [27], [28] has implemented by the no of researcher for solving this problem which are as follows,

Chang [15] has applied the GA algorithm to the shortest path routing problem by using bandwidth as the QoS parameter. He compared the result to that of Dijktra's algorithm and found out that GA has two main advantages. The first one is that the GA algorithm is insensitive to variations in network topologies with respect to route optimality and convergence speed. The second one is that the real computation time of the proposed GA is shorter than that of Dijktra's algorithm.

Munetomo [16], [17] also applied GA to the shortest path routing problem but Munetomo uses delay as the QoS parameter. Due to the use of a single QoS parameter, both of them are basically shortest path routing problems. Munetomo shows that his GA routing algorithm can adapt itself to the change in network load and provide optimal response time. Both Chang and Munetomo use variable length chromosome with each chromosome consisting of nodes that are on the path from sender to receiver.

Other researchers who also use GA to solve the shortest path routing problem (or a variation of it) are Sinclair [18], Shimamoto [19], and Hamdan [20]. Wang [21] and Riedl [22] developed a GA-based QoS routing algorithm to solve the delay-bandwidth-constraint routing problem. On top of finding a feasible path, these two algorithms are also designed to optimize network resource utilization. Wang encode its chromosome as a binary string where the genes represent the link between each pair of nodes in the network. Riedl uses chromosome that contains the weight of the links.

Barolli [23], [24] tries to solve the problem of QoS routing subject to two QoS parameters which are delay and transmission success rate. According to [13], this problem is NP-complete. The chromosome encoding is also different. The network is modeled as a tree and each gene in the chromosome represents a junction on the tree. Koyama [25] takes Barolli's work further by introducing a multi-purpose optimization method that would further improve its performance. Xiang [26] also proposes a GA-based QoS routing algorithm to solve a routing problem subject to multiple QoS parameters. In fact, Xiang's algorithm considers four different QoS parameters: delay, bandwidth, loss-rate and jitter. The chromosome encoding used is similar to [21]. He [18] uses GA to solve the problem of route selection and capacity assignment, which is also NP-complete.

3. ANALYSIS

As per the review of different proposed algorithms, NNs and GAs may also not be promising candidates for supporting real-time applications in mobile ad hoc networks because they involve a large number of iterations in general. However, hardware implementations (e.g., field-programmable gate array (FPGA) chips) of NNs or GAs are extremely fast. Furthermore, they are not very sensitive to network size. The quality of the solution (i.e., computed path) returned by NNs is constrained by their inherent characteristics. GAs are flexible in this regard. The quality (of the solution) can be adjusted as a function of population. In addition, NN hardware is limited in size: it cannot accommodate networks of arbitrary size because of its physical limitation. GA hardware, on the other hand, scales well to networks. The searching range by BWR increases with offered load because a BWR routing process has to explore longer paths as the number of network links without enough bandwidth resources increases.

4. CONCLUSION

In this paper different methods are discussed for solving shortest path finding problem in network. Every algorithm has his advantages and disadvantages. Genetic algorithms performance is comparatively better than other algorithms but no one can solve all the Quality of Service parameters. Today there is huge demand of such algorithm which solves this problem.

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